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B70 09089

SUBJECT: Multi-Segment Modal Synthesis for  
Large Dynamic Systems - Case 620

DATE: September 30, 1970

FROM: S. N. Hou

ABSTRACT

A computer program for modal synthesis, based on the approach presented in Reference 1, has been completed. After breaking a large dynamic system into segments and determining the modes of each segment, this program re-assembles the total system and obtains frequencies and mode shapes of the total system in an expected frequency range, using a limited number of modes selected from each segment.

This program can handle a dynamic system with up to 850 degrees-of-freedom (DOF) by synthesizing with up to 9 segments simultaneously. Frequencies and mode shapes of segments and the locations of inter-segment connections must be specified.

This program has the following applications: (1) to compute modes of a system when the number of DOF is too great for direct eigensolution, (2) to provide more accurate modes at less cost than a direct solution for large systems, and (3) to compute modes of the total system when only segment modes are available from various sources by either computation or testing.

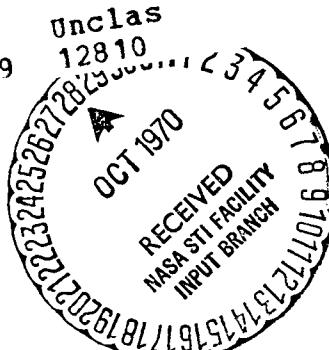
The program is written in FORTRAN V for use on the 1108 UNIVAC computer. For the convenience of massive data handling, the capability is provided for using tape or fastran files for input and output.

N79-72910

(NASA-CR-114102) MULTI-SEGMENT MODAL  
SYNTHESIS FOR LARGE DYNAMIC SYSTEMS CASE 620  
(Bellcomm, Inc.) 76 P

FF No. 602 (C)	SECTION NUMBER
CR-114102	RAGES
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MEMORANDUM FOR FILE

INTRODUCTION

Modal synthesis is a technique for determining the mode shapes and frequencies of a large discrete mass dynamic system by breaking the system into segments, analyzing the segments, and then re-assembling the total system using selected modal information from the segments. This technique offers the advantage of extending the computer capability to a large system by reducing the eigensolution size, and allowing such conveniences as obtaining modal information for the segments from separate sources and by different methods.

Having reviewed the recent developments in modal synthesis techniques, a new approach was presented by the author in Reference 1. This approach serves as the theoretical base for this program, thus this memorandum is intended to be a computer program presentation. Explanation regarding input format, program logic, program limitations, output content, and comments for using the program are emphasized. Numerical examples and a program listing are presented in the Appendix.

MODAL SYNTHESIS

Partition a large discrete mass dynamic system into segments, and consider each segment as a subsystem. If an interface connecting two segments is not physically constrained, as shown in Figures 1 and 2, the interface will provide free boundaries for both adjacent segments. However, any fixed boundaries will remain fixed after partitioning, as the lower end of segment B shown in Figure 2. Thus each segment may be treated as a free-free or constrained subsystem, and the frequencies and mode shapes of each subsystem may be obtained individually either by computation or by testing.

For each subsystem, a certain number of modes will be selected for synthesis. Denoting  $\{\omega_i^2\}$  a diagonal matrix containing frequency squares,  $\{\phi_i\}$  a matrix containing mode shapes by column, and  $\{p_i\}$  a column matrix containing modal

coordinates of the selected modes from subsystem i, we can assemble these modes from all subsystems and have uncoupled equations of motion as follows:

$$\left\{ \begin{array}{c} \ddot{p}_A \\ \ddot{p}_B \\ \vdots \\ \ddot{p}_N \end{array} \right\} + \left[ \begin{array}{ccccc} \omega_A^2 & & & & \\ & \omega_B^2 & & & \\ & & \ddots & & \\ & & & \ddots & \omega_N^2 \\ & & & & \end{array} \right] \left\{ \begin{array}{c} p_A \\ p_B \\ \vdots \\ p_N \end{array} \right\} = [\phi]_C \{F\} , \quad (1)$$

where  $\{F\}$  contains all interface forces, and  $[\phi]_C$  contains the transpose of selected subsystem mode shapes at the interfaces. Taking the structural system in Figure 1 as an example: the system is partitioned into three parts, namely A, B, and C. The mode shapes of subsystem A at interface No. 1 are  $[\phi_{A1}]$ , which are acted on by internal forces  $\{F_1\}$ . Thus we can express

$$[\phi]_C = \left[ \begin{array}{cc} \phi_{A1}^T & 0 \\ -\phi_{B1}^T & \phi_{B2}^T \\ 0 & -\phi_{B2}^T \end{array} \right] , \quad \{F\} = \left\{ \begin{array}{c} F_1 \\ -F_2 \end{array} \right\} . \quad (2)$$

In order to couple the subsystem modes, compatibility conditions for those DOF's at the interfaces will be used. For example, for the same structural system as shown in Figure 1, the displacements at interface No. 1 of subsystem A, denoted as  $\{u_{A1}\}$ , should be equal to the displacements at the interface No. 1 of subsystem B, denoted as  $\{u_{B1}\}$ . The same compatibility conditions should be held at interface No. 2. Thus we have

$$\begin{aligned} \{u_{A1}\} &= \{u_{B1}\} \\ \{u_{B2}\} &= \{u_{C2}\} . \end{aligned} \quad (3)$$

Since

$$\begin{aligned}\{u_{A1}\} &= [\phi_{A1}]\{p_A\} \\ \{u_{B1}\} &= [\phi_{B1}]\{p_B\} \\ \{u_{B2}\} &= [\phi_{B2}]\{p_B\} \\ \{u_{C2}\} &= [\phi_{C2}]\{p_C\} \quad ,\end{aligned}\tag{4}$$

equation (3) gives the following relations:

$$\begin{aligned}[\phi_{A1}]\{p_A\} &= [\phi_{B1}]\{p_B\} \\ [\phi_{B2}]\{p_B\} &= [\phi_{C2}]\{p_C\} \quad ,\end{aligned}\tag{5}$$

which may also be expressed as

$$\left[ \begin{array}{ccc|c} \phi_{A1} & \phi_{B1} & 0 & \\ \hline 0 & \phi_{B2} & -\phi_{C2} & \end{array} \right] \left\{ \begin{array}{c} p_A \\ p_B \\ p_C \end{array} \right\} = \{0\} \quad .\tag{6}$$

If the number of modes selected from subsystems A, B, and C are  $n_A$ ,  $n_B$  and  $n_C$ , respectively, for the modal synthesis, and if the numbers of DOF's at interfaces No. 1 and No. 2 are  $n_1$  and  $n_2$ , respectively, equation (6) will provide  $(n_1 + n_2)$  relations for  $(n_A + n_B + n_C)$  parameters of p's. Thus we can express all p's in terms of  $(n_A + n_B + n_C - n_1 - n_2)$  independent p's. Denoting  $\{p\}$  as a column matrix containing all p's and  $\{q\}$  as a column matrix containing those p's which are chosen as independent parameters, we have

$$\{p\} = [T]\{q\} \quad ,\tag{7}$$

where  $[T]$  is called the "transformation matrix". Reference (3) provides an effective pivoting scheme for such a reduction. If we abbreviate the expression of equation (1) as

$$\{\ddot{p}\} + [\omega^2]\{p\} = [\phi]_C\{F\} \quad ,\tag{8}$$

by substituting equation (7) and restoring symmetry to the matrices, equation (8) becomes

$$[M]_{\text{pseu}} \{\ddot{q}\} + [K]_{\text{pseu}} \{q\} = \{0\} , \quad (9)$$

where

$$[M]_{\text{pseu}} = [T]^T [T] \quad \text{and} \quad (10)$$

$$[K]_{\text{pseu}} = [T]^T [\omega^2] [T]$$

are the pseudo mass and stiffness matrices, respectively, of a synthesized pseudo system. The right hand side of equation (9) is the results of

$$[T]^T [\phi]_c \{F\} = \{0\} , \quad (11)$$

which has been shown in Reference 1. Solving this pseudo system, we have its frequencies  $[\omega^2]_{\text{pseu}}$  and shape vectors  $[\phi]_{\text{pseu}}$ . The frequencies so obtained from the pseudo systems are the frequencies of the total system, while the mode shapes of the total system are obtained by computing

$$[\phi]_t = [\phi] [T] [\phi]_{\text{pseu}} , \quad (12)$$

where

$$[\phi] = \begin{bmatrix} \phi_A \\ \phi_B \\ \vdots \\ \vdots \\ \phi_N \end{bmatrix} . \quad (13)$$

Notice that since equation (3) and (11) hold, geometric compatibility and force equilibrium at the interfaces is satisfied.

Furthermore,

$$\begin{aligned} [\phi]_t^T [M] [\phi]_t &= \left( [\phi]_{\text{pseu}}^T [T]^T [\phi]^T \right) [M] \left( [\phi] [T] [\phi]_{\text{pseu}} \right) \\ &= [\phi]_{\text{pseu}}^T \left( [T]^T \left( [\phi]^T [M] [\phi] \right) [T] \right) [\phi]_{\text{pseu}} \end{aligned} \quad (14)$$

Since

$$[\phi]^T [M] [\phi] = [I] , \quad \text{and}$$

$$[\phi]_{\text{pseu}}^T \left( [T]^T [T] \right) [\phi]_{\text{pseu}} = [\phi]_{\text{pseu}}^T [M]_{\text{pseu}} [\phi]_{\text{pseu}} = [I] ,$$

we have

$$[\phi]_t^T [M] [\phi]_t = [I] .$$

Thus the mode shapes so computed are already normalized to a unit modal mass.

#### PROGRAM LOGIC

The program consists of a MAIN program for controlling operations, and sixteen subroutines for performing special functions. Their interrelations are shown by the flow chart in Figure 3. All subroutines can be divided into the following four groups according to their major task:

1. Subroutine INPT inputs all required data, which includes mode shapes and frequencies selected from all segments, and details of interface locations. The input modal data are pre-stored on tape, and the interface data are in the NAMELIST. The rigid body mode shapes, if there are any, may be stored in any order among elastic modes on the same record, or stored on a separate record of the same tape.
2. Subroutine SYNT is the program that performs modal synthesis. It calls subroutine DSPACE for the transformation matrix  $[T]$ . Then SYNT creates a pseudo system by generating the pseudo mass and stiffness matrices. For each stage, subroutine OUPT is called by SYNT for printing out the intermediate results.

3. Subroutine MODES performs modal analysis for the pseudo system generated by SYNTH. First, it calls subroutine STEP1, which calls subroutine MAP for computing a preliminary set of frequencies and mode shapes of the pseudo system. Then, it calls subroutine STEP2, which calls subroutine VECTOR for improving the modes previously obtained by subroutine MAP, using "Generalized Rayleigh Methods".<sup>(4)</sup> Finally, it calls subroutine STEP3 for computing the mode shapes of the pseudo system.
4. Subroutine SHAPES computes the mode shapes of the synthesized total system, and outputs the final results of the modal synthesis. Subroutines SHAP1 and SHAP2 are called by SHAPES.

Owing to limited computer core storage, overlay techniques for re-using the storage space has been stressed. The logic used was a combined consideration of computation scheme requirements and the convenience of data overlay.

#### PROGRAM LIMITATIONS

After some trade-off among all major considerations the capacity of this program is limited as follows:

1. Modal synthesis is performed over several segments of a system simultaneously. The total number of segments should not exceed 9.
2. For the overall system to be synthesized, the number of DOF should not exceed 850.
3. For each segment, the number of DOF should not exceed 150.
4. The number of modes selected for synthesis from any segment should not exceed 50.
5. The total number of modes used for synthesis from all segments should not exceed 150, which, after deducting the total number of inter-segment constraints, should not exceed 140.
6. The total number of inter-segment constraints should not exceed 50.

7. The number of modes requested for output by synthesis should not exceed 60.
8. The program can handle up to 6 rigid body modes.

#### PROGRAM INPUT FORMAT

Input to the modal synthesis program should be prepared according to the following sequence:

1. Preparation of Segment Modal Data - Mode shapes (normalized to a unit modal mass) and frequencies (in Hz) of each segment should be pre-computed and stored on tape according to the following order:

((SHAP(I,J), J = 1,NM), I = 1,ND)

(FREQ(I), I = 1,NM)

where SHAP(I,J) is a two dimensional array for mode shapes, FREQ(I) is a one dimensional array for frequencies, NM is the number of modes of the segment, and ND is the number of DOF's of the segment. Thus there are two records per segment.

The modal data for segments need not be stored on a single tape. In addition, the rigid body modes need not be stored on the same record with the elastic modes of the same segment.

2. Preparation of Control Cards - The control card format needed for running the modal synthesis program on the 1108 UNIVAC computer is as follows, if tapes are used.

@ RUN

@ HDG

@ ASG,TM N<sub>1</sub>,T,N<sub>2</sub>

-----

@ ASG,TM MODALSYNTH.,T,2115

@ MSG,W (WAIT FOR TAPE MOUNT)

@ COPIN,ARS MODALSYNTH.

@ XQT ABSELM

\$INPUT\*  
----- ( NAMELIST input )  
----- see next section  
\$END

@FIN

where

$N_1$  = Scratch mass storage unit number used for  
the input data from tape number  $N_2$ .

$N_2$  = Tape number for segment modal data.

If more than one tape is used for input data, each tape should be assigned a scratch mass storage unit number. In other words, a control card similar to the third one shown above should be used for each tape. In addition,  $N_1$  should not be one of those unit numbers which already has been used in this program package (i.e., 11 to 36).

3. NAMELIST Input - The following arguments and arrays in the NAMELIST should be specified in punch cards for program input:

```
$INPUT*
NCASE = ___,  

NTS = ___, NV = ___,  

ND = ___, ___, ..., ___,  

NMP = ___, ___, ..., ___,  

NMQ = ___, ___, ..., ___,  

NML = ___, ___, ..., ___,  

NTR = ___, NR = ___, ___, ..., ___,  

NRD = ___, ___, ___, ___, ___, ___, ___, ..., ___, ___,  

.....  

_____, ___, ___, ___, ___, ___, ___, ___, ..., ___, ___,  

NRG = ___, ___, ..., ___,  

NRGSQ = ___, ___, ___, ___, ___, ___,  

.....  

_____, ___, ___, ___, ___, ___,  

NTAPE = ___, ___, ..., ___,  

NREC = ___, ___, ..., ___,  

NRECRB = ___, ___, ..., ___,  

$END
```

where:

- NCASE = Case number for job identification.
- NTS = Number of segments by partitioning.
- NV = Number of modes of the overall system requested in the final output of synthesis.
- ND = An array specifying successively the number of DOF in each segment.
- NMP = An array specifying successively the number of modes of each segment available on tape.
- NMQ = An array specifying successively the number of modes to be selected from each segment for synthesis.
- NML = An array specifying successively for each segment the mode number to start selection of elastic modes on tape.
- NTR = Total number of inter-segment constraints.
- NR = An array specifying successively for each segment the number of DOF's restrained by adjacent segments.
- NRD = An array specifying in pairs the constraint number and the DOF number for each constraint, from segment to segment.
- NRG = An array specifying successively the number of rigid body modes in each segment.
- NRGSQ = An array specifying the mode number of each rigid body mode on tape from segment to segment.
- NTAPE = An array specifying successively for each segment the storage unit number assigned for segment modal input from tape.
- NREC = An array specifying successively the record position number of mode shapes for each segment.
- NRECRB = An array specifying successively the record position number of rigid body mode shapes for each segment (= 0 if on the same record with elastic mode shapes of the segment).

PROGRAM OUTPUT

The intermediate and final results through the computation scheme are printed out and also stored on the scratch mass storage units as follows:

1. Contents of printed output:
  - a. All input in the NAMELIST,
  - b. transformation matrix - row by row,
  - c. pseudo mass matrix - row by row,
  - d. pseudo stiffness matrix - row by row,
  - e. frequencies and mode shapes of the pseudo system - mode by mode,
  - f. frequencies and mode shapes of the pseudo system after being improved by the "Generalized Rayleigh Method" - mode by mode,
  - g. final results of modal synthesis,
    - (1) a list of all synthesized frequencies (in cps)
    - (2) a specified number of mode shapes - mode by mode following the ascending order of frequencies.
2. The assigned scratch mass storage unit numbers:
  - a. #11-34 are reserved for internal operations and should not be used for tape assignment,
  - b. the first record of #35 contains the structural frequencies obtained from synthesis; the record length equals the total number of segment modes selected for synthesis minus the total number of inter-segment constraints,
$$\left( \text{i.e. } \frac{\text{Record Length}}{\sum_{I=1}^{\text{NTS}} \text{NMQ}(I) - \text{NTR}} \right) .$$
  - c. #36 contains mode shapes of the assembled overall system; there is one record for each DOF with a

record length of NV; records are in the order of DOF number from segment to segment; the total record number is equal to

$$\sum_{I=1}^{NTS} ND(I) .$$

### CONCLUSIONS

This program can compute modes of a large dynamic system when the size of the system is too great for direct eigensolution. It is readily shown (see numerical example 1 in Appendix A) that a large saving in computer time can be obtained by partitioning a large system using modal synthesis, with more accurate results, than a direct eigensolution. In addition, the program stores the synthesis results on tape or fastran file. The format is so arranged that the output can be used as input to additional synthesis, to analyze much larger original systems.

The modal data of segments are the major input, which may be obtained from various sources by either computation or dynamic testing. Special attention is needed for preparing the segment modes when a segment is considered free-free. Since conventional eigensolutions usually yield ill-orthogonal modes whenever repeated eigenvalues occur, the rigid body modes are poor and the lowest few elastic modes have a larger error than the higher modes. Thus a treatment for improving the orthogonality among the low modes of the segments is necessary. There are various ways to do this. A method adopted by this program is the "Generalized Rayleigh Method,"<sup>(4)</sup> which is used for improving the eigensolution of the pseudo system.

For efficiency of massive data handling, the capability for using tapes or fastran files for both input and output is provided. The advantage of data overlay techniques enables the program to re-use the same core storage several times, and as such the program capability is much enlarged. The program also provides a built-in check for assuring the consistency of input data, and prints out and stores on scratch files the intermediate results for the program user's evaluation. Such intermediate output will be helpful to the user for tracing the theoretical aspects of the program by comparing them with equations.

Furthermore, two numerical examples are presented in Appendix A. In the first example, modes of a 200 DOF free-free beam are obtained by breaking the beam into five segments.

Synthesis results are compared with results using direct eigen-solution. It was shown that the synthesis results cost 169 computer charge units in comparison with a cost of 1334 charge units for a direct solution of the whole beam. The frequencies and mode shapes obtained by synthesis are more accurate. In the second example, 4 solar arrays and the rack of the Apollo telescope mount for the orbital workshop are assembled for modal solution of a 411 DOF system. Example 2 is used to demonstrate a typical application of this program.

ACKNOWLEDGEMENT

Appreciation is extended to the following colleagues in the Structural Dynamics Group of the Space Vehicle Dynamics Department, Bellcomm, Inc., who have made positive contributions to the formation of this program.

1. Kaufman, S. - His contribution is cited in Reference 3 on the subroutine DSPACE, which automates the computation scheme for generating a transformation matrix.
2. Stephens, H. E. - His contribution regarding massive data input was adopted in the program. His critical test runs<sup>(5)</sup> provided valuable clues for debugging and improving the program.
3. Vandergraft, J. A. - His contribution is cited in Reference 4 on subroutines VECTOR, TRAIP, QR, and TRANSF, which are helpful for improving the lowest few modes of the pseudo system, especially for a free-free system.

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4. Vandergraft, J. S., "Generalized Rayleigh Methods With Applications to Finding Eigenvalues of Large Matrices," Technical Report 70-105, January 1970, University of Maryland, College Park, Md.
5. Stephens, H. E., "Orbital Workshop Structural Modal Analysis," Memorandum for File B70-08031, August 14, 1970, Bellcomm, Inc., Washington, D. C.

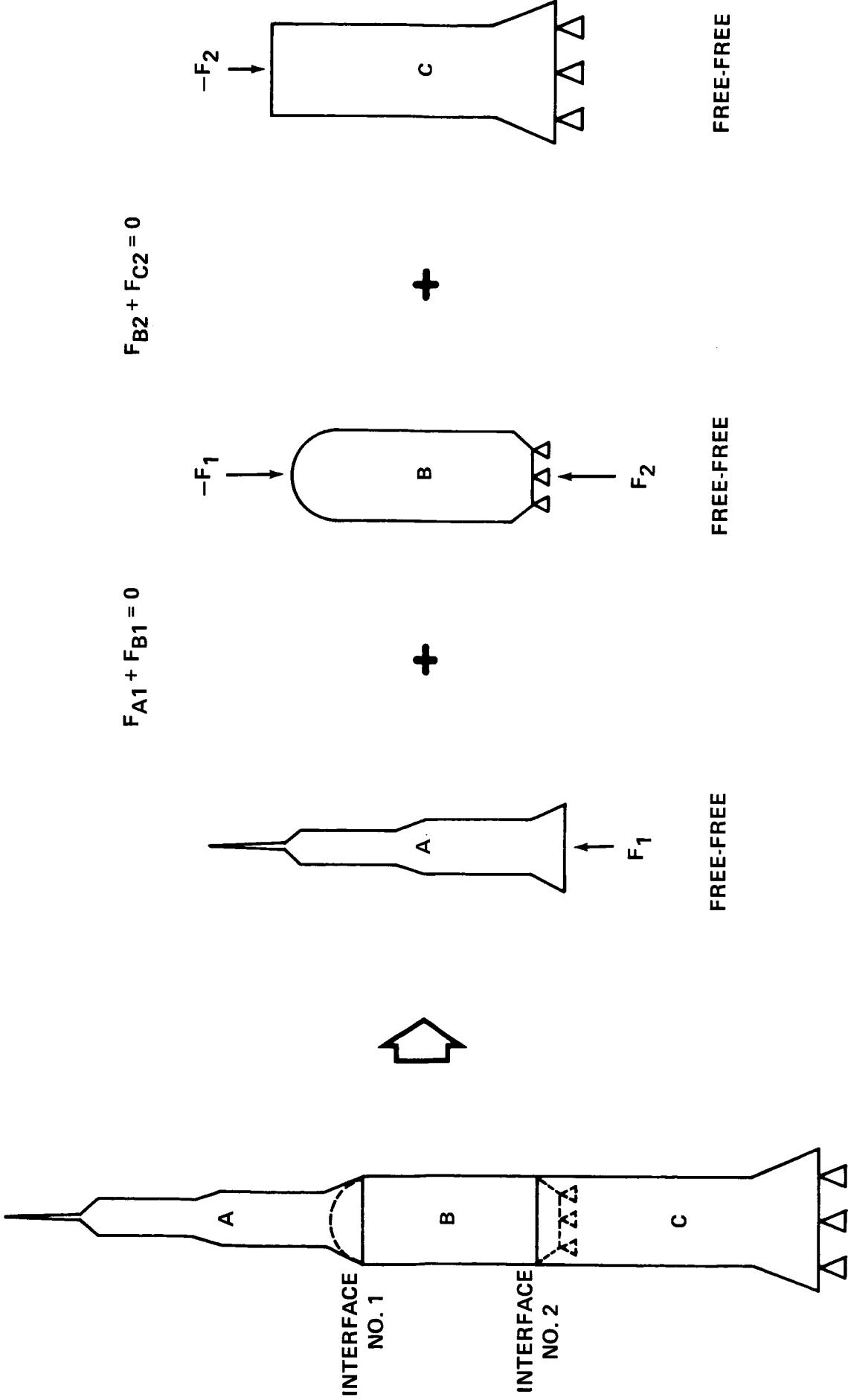


FIGURE 1 - PARTITIONING A FREE-FREE SYSTEM

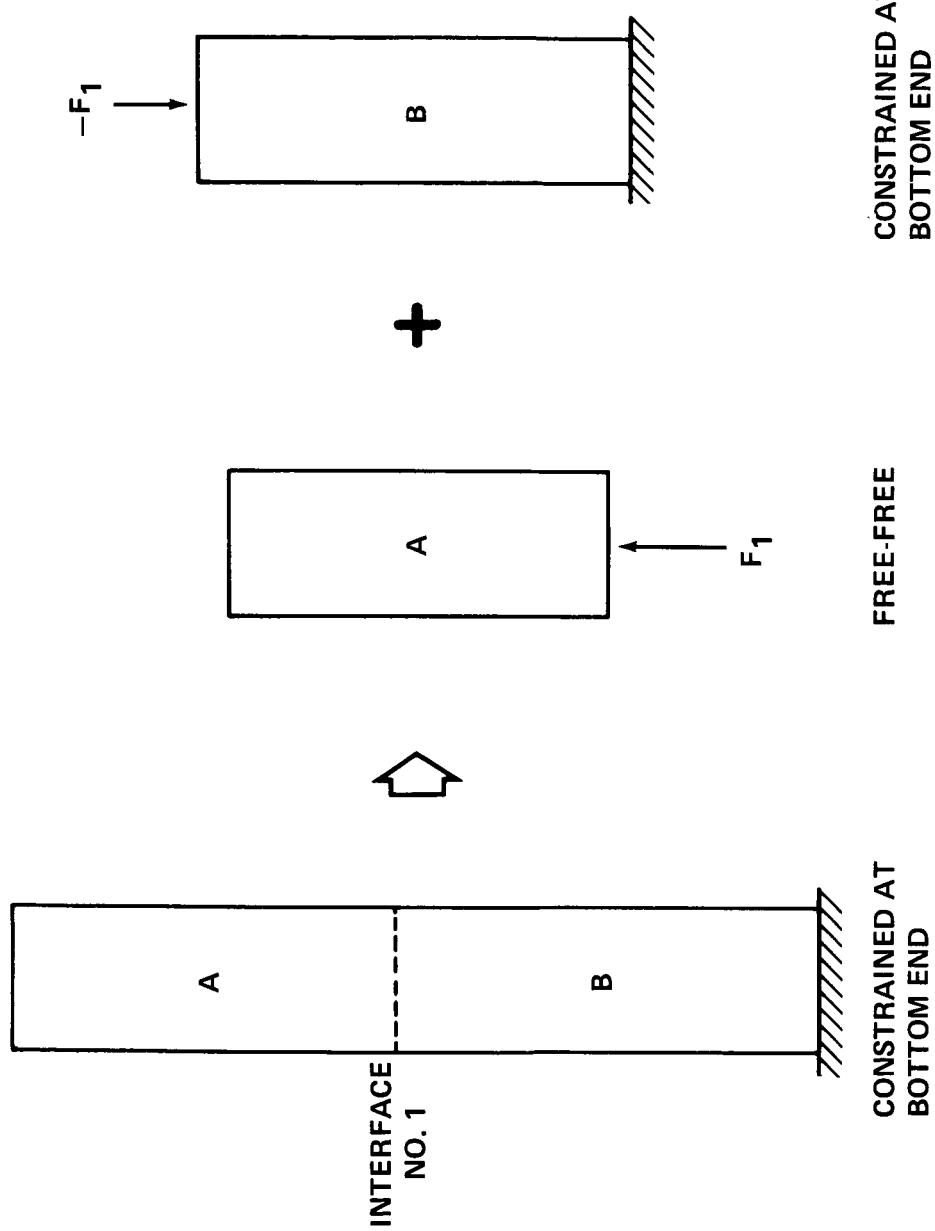


FIGURE 2 - PARTITIONING A CONSTRAINED SYSTEM

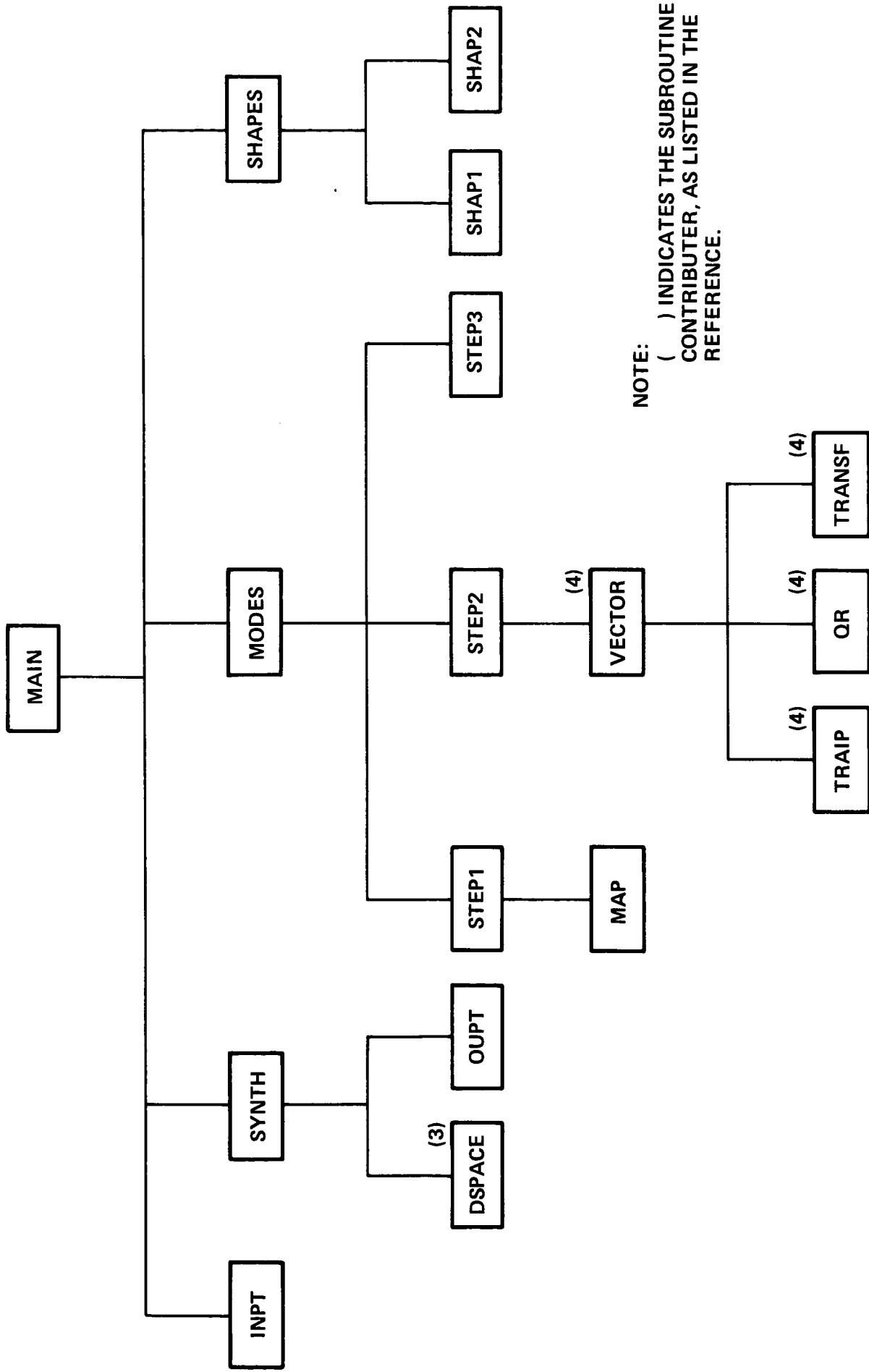


FIGURE 3 – SUBROUTINE FLOW CHART

## APPENDIX A

### NUMERICAL EXAMPLES

EXAMPLE 1: As shown in Figure A1, an elastic, homogeneous, free-free beam, with a uniform circular cross section ( $R = 1"$ ), 100" in length, 2 pounds per cubic in. in weight, and  $1 \times 10^4$  psi in elastic modulus, was discretized into 101 evenly spaced mass points. Each mass point has two DOF's, lateral displacement and rotation, thus the overall system consists of 202 DOF.

To compute frequencies and mode shapes (say the first 40), we can always perform modal analysis directly, which would cost 1334 charge units using the UNIVAC 1108 computer. However, if we partition the beam into five segments and select from each segment a limited number of segment modes in the same frequency range, we can obtain more accurate modes at a cost of only 169 charge units for the synthesis, and an additional 31 charge units to compute the segment frequencies and mode shapes. See Table 1 for a comparison of the modal results.

The NAMELIST input used is as shown in Table 2. Portions of the output are attached.

A-2

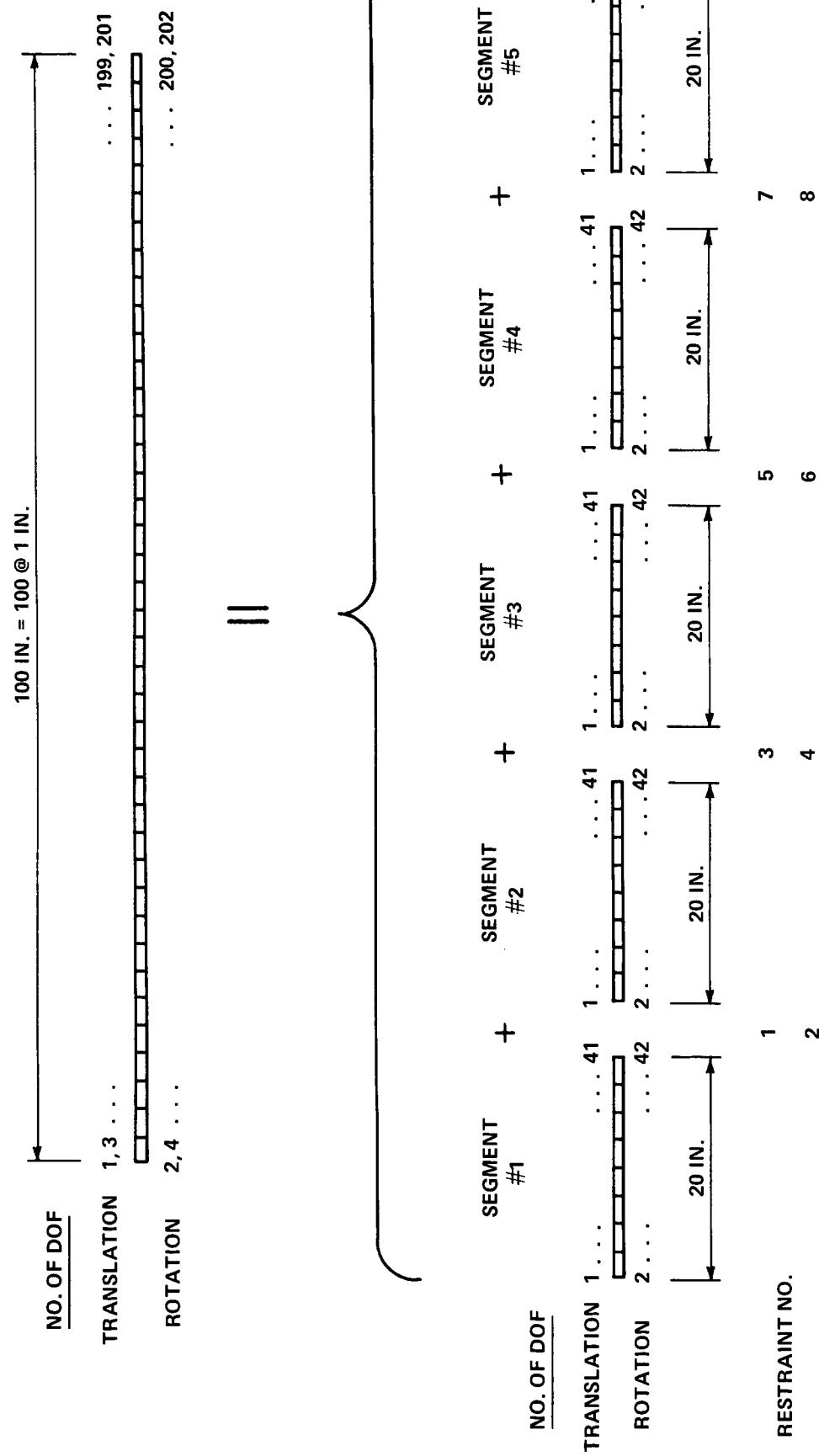


FIGURE A1 - PARTITIONING A FREE-FREE BEAM

TABLE 1  
COMPARISON OF MODAL RESULTS  
FOR A 202-DOF FREE-FREE BEAM

I. Normal Frequencies (cps):

Modes	By Direct Eigensolutions Without RQ	With RQ*	By Modal Synthesis	Exact Solution
1st-Rigid	0.196	0.057	0.003	0.
2nd-Rigid	0.263	0.058	0.003	0.
1st-Elastic	0.318	0.229	0.248	0.247
2nd-Elastic	0.713	0.678	0.683	0.682
3rd-Elastic	1.348	1.331	1.338	1.337

\*Generalized Raleigh Quotient Method is applied.

II. Mode Shapes:

A. First Elastic Mode:

X L	By Direct Eigensolutions Without RQ	With RQ	By Modal Synthesis	Exact Solution
0.	-2.111	-1.651	-1.569	-1.565
0.1	-1.335	-0.939	-0.845	-0.842
0.2	-0.603	-0.264	-0.157	-0.153
0.3	0.014	0.304	0.423	0.426
0.4	0.460	0.685	0.812	0.814
0.5	0.689	0.821	0.952	0.952
0.6	0.674	0.689	0.814	0.814
0.7	0.424	0.316	0.428	0.426
0.8	-0.003	-0.237	-0.151	-0.153
0.9	-0.528	-0.890	-0.837	-0.842
1.0	-1.028	-1.506	-1.561	-1.565

TABLE 1 (CONTINUED)

## B. Second Elastic Mode:

$\frac{X}{L}$	By Direct Eigensolutions Without RQ	With RQ	By Modal Synthesis	Exact Solution
0.	1.541	1.572	1.571	1.565
0.1	0.334	0.351	0.361	0.356
0.2	-0.638	-0.631	-0.616	-0.622
0.3	-1.047	-1.035	-1.037	-1.037
0.4	-0.763	-0.734	-0.757	-0.756
0.5	0.006	0.381	-0.004	0.
0.6	0.772	0.787	0.751	0.756
0.7	1.040	1.030	1.037	1.037
0.8	0.592	0.562	0.624	0.622
0.9	-0.426	-0.459	-0.349	-0.356
1.0	-1.539	-1.564	-1.556	-1.565

## C. Third Elastic Mode:

0.	1.558	1.572	1.573	1.565
0.1	-0.121	-0.097	-0.078	-0.081
0.2	-1.048	-1.018	-0.999	-1.005
0.3	-0.639	-0.604	-0.625	-0.621
0.4	0.510	0.543	0.506	0.513
0.5	1.089	1.105	1.116	1.112
0.6	0.452	0.450	0.516	0.513
0.7	-0.672	-0.678	-0.619	-0.621
0.8	-0.978	-0.974	-1.002	-1.005
0.9	0.037	0.050	-0.090	-0.081
1.0	1.541	1.358	1.550	1.565

TABLE 2

INPUT FOR 5-SEGMENT MODAL SYNTHESIS  
OF A FREE-FREE BEAM

\$INPUT\*

NCASE = 1,  
NTS = 5, NV = 40,  
ND = 42, 42, 42, 42, 42,  
NMP = 30, 30, 30, 30, 30,  
NMQ = 20, 20, 20, 20, 20,  
NML = 3, 3, 3, 3, 3,  
NTR = 8, NR = 2, 4, 4, 4, 2,  
NRD = 1, 41, 2, 42,  
1, 1, 2, 2, 3, 41, 4, 42,  
3, 1, 4, 2, 5, 41, 6, 42,  
5, 1, 6, 2, 7, 41, 8, 42,  
7, 1, 8, 2,  
NRG = 2, 2, 2, 2, 2,  
NRGSQ = 1, 2, 0, 0, 0, 0,  
1, 2, 0, 0, 0, 0,  
1, 2, 0, 0, 0, 0,  
1, 2, 0, 0, 0, 0,  
NTAPE = 1, 1, 1, 1, 1,  
NREC = 1, 0, 1, 1, 1,  
NRECRB = 0, 0, 0, 0, 0,  
\$END

## MODAL SYNTHESIS

NO. OF SEGMENTS = 5  
 NO. OF INTERFACE RESTRAINTS = 8  
 NO. OF DOF OF OVERALL SYSTEM = 202

## FOR SEGMENT NO. 1

NO. OF DOF = 42  
 NO. OF MODES AVAILABLE = 30  
 NO. OF MODES USED IN SYNTHESIS = 20 WHICH INCLUDES  
 2 RIGID BODY MODES  
 18 ELASTIC MODES (START MODE NO. 3)  
 NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 2

RESTRAINT NO.	1	2
DOF NO.	41	42

## STORAGE OF SEGMENT MODES

TAPE UNIT NO.	1
RECORD POSITION NO.	= 1
RIGID BODY MODE NOS.	= 1 1 2

## FOR SEGMENT NO. 2

NO. OF DOF = 42  
 NO. OF MODES AVAILABLE = 30  
 NO. OF MODES USED IN SYNTHESIS = 20 WHICH INCLUDES  
 2 RIGID BODY MODES  
 18 ELASTIC MODES (START MODE NO. 3)  
 NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 4

RESTRAINT NO.	1	2	3	4
DOF NO.	1	2	41	42

## STORAGE OF SEGMENT MODES

TAPE UNIT NO.	1
RECORD POSITION NO.	= 1
RIGID BODY MODE NOS.	= 1 1 2

## 5-SEG MODAL SYNTHESIS FOR BEAM

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## FOR SEGMENT NO. 3

NO. OF DOF = 42

NO. OF MODES AVAILABLE = 30

NO. OF MODES USED IN SYNTHESIS = 20 WHICH INCLUDES

2 RIGID BODY MODES (START MODE NO. 3)  
18 ELASTIC MODES

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 4

RESTRAINT NO. 3 4 5 6  
DOF NO. 1 2 41 42

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
RECORD POSITION NO. = 1  
RIGID BODY MODE NOS. = 1 1 2

## FOR SEGMENT NO. 4

NO. OF DOF = 42

NO. OF MODES AVAILABLE = 30

NO. OF MODES USED IN SYNTHESIS = 20 WHICH INCLUDES

2 RIGID BODY MODES (START MODE NO. 3)  
18 ELASTIC MODES

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 4

RESTRAINT NO. 5 6 7 8  
DOF NO. 1 2 41 42

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
RECORD POSITION NO. = 1  
RIGID BODY MODE NOS. = 1 1 2

## FOR SEGMENT NO. 5

NO. OF DOF = 42

NO. OF MODES AVAILABLE = 30

NO. OF MODES USED IN SYNTHESIS = 20 WHICH INCLUDES

2 RIGID BODY MODES (START MODE NO. 3)  
18 ELASTIC MODES

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 2

RESTRAINT NO. 7 8  
 DOF NO. 1 2

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
 RECORD POSITION NO. = 1  
 RIGID BODY MODE NOS. = 1 2

## TRANSFORMATION MATRIX

ROW	1	2	3	4	5	6	7	8	9	10
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.20
21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.30
31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.40
41	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.50
51	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.60
61	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.70
71	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.80
81	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.90
91	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.100
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.20
21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.30
31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.40
41	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.50
51	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.60
61	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.70
71	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.80
81	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.90
91	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.100
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
11	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.20
21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.30
31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.40
41	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.50
51	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.60
61	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.70
71	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.80
81	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.90
91	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.100
1	.6607+00	.5787+00	.4971+00	.4188+00	.3459+00	.2799+00	.2213+00	.1705+00	.1274+00	.9190-01
11	-.6395-01	.4367-01	-.8313+00	.5891+00	.9873+00	.9612+00	.9036+00	-.8580+00	.7743+00	.7128+00
21	-.6122+00	.5452+00	-.4416+00	-.3810+00	.2864+00	-.2395+00	-.1595+00	-.1286+00	-.6436-01	.4895-01
31	-.4233+00	-.9181+00	-.1838-02	.1035-J2	-.9300+00	-.8769+00	-.2336-02	.2394-02	-.4548-02	.4652-02
41	-.6463-02	-.6545-02	.7915-U2	.7945-02	-.8890-02	.8890-02	.9510-02	.9896-02	-.9933-02	.50
51	-.1017-01	-.1022-U1	-.5075-U3	.3600-03	-.6036-03	-.5869-03	.5523-03	.4733-03	-.4352-03	.40
61	-.3742-03	.3329-U3	-.2700-U3	-.1751-U3	-.2326-U3	-.1462-U3	-.9753-U4	-.7851-U4	-.3934-U4	.70
71	-.9728+00	-.7399+00	-.4697-U6	-.5703-U6	-.8128+00	-.7247-U6	-.1427-U5	.2117-U5	-.2779-05	.80
81	-.3949-05	-.4431-U5	-.4836-05	-.5167-U5	-.5431-05	-.5649-U5	-.5937-U5	-.6046-U5	-.6137-05	.90
91	-.6214-05	-.6276-05	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.100

	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20																																																										
1	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20																																												
1	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120																																								
1	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120																																																												
1	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200

PSEUDO MASS MATRIX

PSEUDO MASS MATRIX

**ROE**      **3**  
**• 5640+00**      **• 5576+00**      **• 1542+01**      **-• 5229+00**      **-• 5028+00**      **-• 4827+00**      **-• 4637+00**      **-• 4465+00**      **-• 4316+00**      **-• 4195+00**      **10**

ROW 91

-4305-05	-3819-05	-3333-05	-2863-05	-2423-05	-2024-05	-1668-05	-1359-05	-1097-05	-8804-06	10
1	-7107-06	-5877-06	-1238-03	-4104-04	-1518-03	-1930-03	-2082-03	-2428-03	-2539-03	20
11	-2859-03	-3021-03	-3027-03	-3104-03	-3078-03	-3098-03	-3064-03	-3058-03	-3035-03	30
21	-2607-05	-5677-05	-4629-02	-1973-02	-5851-05	-5555-05	-5228-02	-5102-02	-5104-02	40
31	-4738-02	-4135-02	-4216-02	-3489-02	-3655-02	-2886-02	-3152-02	-2392-02	-2758-02	50
41	-2494-02	-1817-02	-4923-01	-1292-02	-9245-01	-1548+00	-1980+00	-2536+00	-2932+00	60
51	-3710+00	-4034+00	-4255+00	-4444+00	-4582+00	-4672+00	-4761+00	-4792+00	-4868+00	70
61	-6069-05	-4769-05	-1642-01	-6879-02	-5191-05	-1188+00	-1712+00	-2218+00	-2695+00	80
71	-3514+00	-3838+00	-4103+00	-4312+00	-4473+00	-4594+00	-4686+00	-4757+00	-4814+00	90
81	-4191+01	-4941+01	-0000	-0000	-0000	-0000	-0000	-0000	-0000	100

ROW 92

-4265-05	-3765-05	-3265-05	-2783-05	-2334-05	-1926-05	-1563-05	-1248-05	-9811-06	-7610-06	10
1	-5879-06	-4625-06	-1367-03	-4684-04	-1659-03	-2072-03	-2218-03	-2664-03	-2920-03	20
11	-2965-03	-3121-03	-3114-03	-3184-03	-3145-03	-3159-03	-3115-03	-3105-03	-3059-03	30
21	-2643-05	-5745-05	-4717-05	-2007-02	-5879-05	-5567-05	-5231-02	-5103-02	-4662-02	40
31	-4651-02	-4040-02	-4093-02	-3358-02	-3506-02	-2729-02	-2985-02	-2217-02	-2579-02	50
41	-2306-02	-1622-02	-6890-01	-1013-01	-1140+00	-1765+00	-2188+00	-2741+00	-3574+00	60
51	-3875+00	-4188+00	-4390+00	-4568+00	-4688+00	-4769+00	-4842+00	-4867+00	-4927+00	70
61	-6115-05	-4745-05	-8077-03	-1931-01	-5185-05	-9970-01	-1534+00	-2057+00	-2552+00	80
71	-3411+00	-3756+00	-4040+00	-4268+00	-4445+00	-4582+00	-4687+00	-4769+00	-4836+00	90
81	-4941+00	-1498+01	-0000	-0000	-0000	-0000	-0000	-0000	-0000	100

## PSUEDU STIFFNESS MATRIX

ROW 1

-1989+07	-1543+07	-1685+07	-1800+07	-1892+07	-1964+07	-2022+07	-2068+07	-2106+07	-2137+07	10
1	-2164+07	-2164+07	-2164+06	-2168+06	-6829+06	-9789+06	-1111+07	-1406+07	-1481+07	20
11	-1767+07	-2120+07	-1951+07	-2156+07	-2046+07	-2222+07	-2086+07	-2247+07	-2102+07	30
21	-1641+06	-1937+06	-1389+05	-7579+04	-978+06	-7381+06	-1697+05	-1799+05	-3306+05	40
31	-4698+05	-4926+05	-5753+05	-5980+05	-6462+05	-6692+05	-6907+05	-7159+05	-7193+05	50
41	-7393+05	-7694+05	-4107+04	-2854+04	-4980+04	-5029+04	-4855+04	-4814+04	-4483+04	60
51	-3909+04	-3741+04	-3233+04	-3072+04	-2574+04	-2460+04	-2012+04	-1964+04	-1582+04	70
61	-2533+06	-1183+07	-6966+01	-8456+01	-9684+06	-1074+02	-2115+02	-3137+02	-4118+02	80
71	-5852+02	-6567+02	-7167+02	-7658+02	-8050+02	-8360+02	-8604+02	-8800+02	-8961+02	90
81	-9210+02	-9302+02	-0000	-0000	-0000	-0000	-0000	-0000	-0000	100

ROW 2

-1543+07	-2667+07	-1890+07	-2019+07	-2123+07	-2204+07	-2269+07	-2320+07	-2362+07	-2398+07	10
1	-2428+07	-2452+07	-5058+06	-2434+06	-7664+06	-1099+07	-1246+07	-1578+07	-1662+07	20
11	-1983+07	-2257+07	-2189+07	-2419+07	-2296+07	-2493+07	-2340+07	-2521+07	-2536+07	30
21	-1842+06	-2175+06	-1558+05	-8504+04	-5853+06	-8279+06	-1905+05	-2019+05	-3709+05	40
31	-5271+05	-6527+05	-6456+05	-6871+05	-7251+05	-7509+05	-8033+05	-8071+05	-8391+05	50
41	-8295+05	-8633+05	-4608+04	-3202+04	-5688+04	-5643+04	-5401+04	-5030+04	-4893+04	60
51	-4336+04	-4198+04	-3626+04	-3447+04	-2888+04	-2761+04	-2204+04	-1775+04	-1801+04	70
61	-2839+06	-1327+07	-7816+01	-9488+01	-1086+07	-1205+02	-3520+02	-4620+02	-5645+02	80

## MODAL SYNTHESIS RESULTS

LIST OF FREQUENCIES (CPS)

*25419-02	*35314-02	*24802+00	*68321+00	*13382+01	*22128+01	*32831+01	*46859+01	*60968+01	*78186+01
*97612+01	*11828+02	*14175+02	*1669+02	*19413+02	*22340+02	*25322+02	*28632+02	*32096+02	*35741+02
*39606+02	*43320+02	*47640+02	*51814+02	*56228+02	*60830+02	*65247+02	*70215+02	*75224+02	*80373+02
*85716+02	*90525+02	*96262+02	*10181+02	*10744+03	*11321+03	*11852+03	*12475+03	*13082+03	*13698+03
*14328+03	*14863+03	*15654+03	*16184+03	*16816+03	*17457+03	*18025+03	*18735+03	*19399+03	*20068+03
*20741+03	*21279+03	*22052+03	*22705+03	*23354+03	*24007+03	*24564+03	*25321+03	*25992+03	*26664+03
*27327+03	*27821+03	*28641+03	*29261+03	*29875+03	*30486+03	*30968+03	*33743+03	*32370+03	*32993+03
*33691+03	*33997+03	*34816+03	*35342+03	*35863+03	*36377+03	*36777+03	*38467+03	*37992+03	*38506+03
*38975+03	*39246+03	*40007+03	*40366+03	*40723+03	*41070+03	*41316+03	*41862+03	*42221+03	*42555+03
*42801+03									

## NORMAL FREQUENCY # \* 2542-02 CPS

SEGMENT	1	MODE NO.	1	1	1	1	1	1	1
1	-*49446-01	-*1284-01	-*6229-01	-*1284-01	-*7513-01	-*1284-01	-*8797-01	-*1284-01	-*1283-01
	-*1136+00	-*1283-01	-*1266+00	-*1283-01	-*1393+00	-*1283-01	-*1521+00	-*1283-01	-*1283-01
	-*1778+00	-*1283-01	-*1906+00	-*1283-01	-*2034+00	-*1283-01	-*2163+00	-*1283-01	-*1283-01
	-*2419+00	-*1283-01	-*2547+00	-*1283-01	-*2676+00	-*1283-01	-*2804+00	-*1283-01	-*1283-01
2	-*3061+00	-*1283-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*3061+00	-*1283-01	-*3189+00	-*1283-01	-*3317+00	-*1283-01	-*3445+00	-*1282-01	-*3574+00
	-*3722+00	-*1282-01	-*4830+00	-*1282-01	-*3958+00	-*1282-01	-*4086+00	-*1282-01	-*4215+00
	-*4343+00	-*1281-01	-*471+00	-*1281-01	-*4599+00	-*1281-01	-*4727+00	-*1281-01	-*4855+00
3	-*4983+00	-*1281-01	-*5111+00	-*1281-01	-*5239+00	-*1281-01	-*5368+00	-*1281-01	-*5496+00
	-*5624+00	-*1281-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*8182+00	-*1278-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*8182+00	-*1281-01	-*5752+00	-*1281-01	-*5880+00	-*1281-01	-*6006+00	-*1281-01	-*6136+00
4	-*6264+00	-*1280-01	-*6392+00	-*1280-01	-*6520+00	-*1280-01	-*6648+00	-*1279-01	-*6776+00
	-*6904+00	-*1279-01	-*7032+00	-*1279-01	-*7160+00	-*1278-01	-*7287+00	-*1278-01	-*7415+00
	-*7543+00	-*1278-01	-*7671+00	-*1278-01	-*7799+00	-*1278-01	-*7927+00	-*1278-01	-*8055+00
	-*8182+00	-*1278-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
5	-*8182+00	-*1278-01	-*8310+00	-*1278-01	-*8438+00	-*1278-01	-*8566+00	-*1278-01	-*8694+00
	-*8821+00	-*1277-01	-*8949+00	-*1277-01	-*9077+00	-*1276-01	-*9204+00	-*1276-01	-*9332+00
	-*9459+00	-*1275-01	-*9587+00	-*1275-01	-*9714+00	-*1275-01	-*9842+00	-*1275-01	-*9969+00
	-*1010+01	-*1275-01	-*1022+01	-*1275-01	-*1035+01	-*1275-01	-*1048+01	-*1275-01	-*1061+01
6	-*1073+01	-*1275-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*1073+01	-*1275-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*1137+01	-*1273-01	-*1150+01	-*1273-01	-*1163+01	-*1272-01	-*1175+01	-*1272-01	-*1188+01
	-*1201+01	-*1271-01	-*1213+01	-*1270-01	-*1226+01	-*1270-01	-*1239+01	-*1270-01	-*1251+01
7	-*1264+01	-*1270-01	-*1277+01	-*1270-01	-*1290+01	-*1270-01	-*1302+01	-*1270-01	-*1315+01
	-*1328+01	-*1270-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*1328+01	-*1270-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	-*1328+01	-*1270-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000

## NORMAL FREQUENCY # \* 3531-02 CPS

## 5-SEG MODAL SYNTHESIS FOR BEAM

DATE 071370 PAGE 91

SEGMENT 1		SEGMENT 2		SEGMENT 3		SEGMENT 4		SEGMENT 5	
1	.1566+01	-.2388+01	.1542+01	-.2388+01	.1518+01	-.2388+01	.1495+01	-.2388+01	.1471+01
11	.1447+01	-.2388+01	.1423+01	-.2388+01	.1399+01	-.2389+01	.1375+01	-.2389+01	.1351+01
21	.1327+01	-.2390+01	.1303+01	-.2390+01	.1280+01	-.2391+01	.1256+01	-.2391+01	.1232+01
31	.1208+01	-.2391+01	.1184+01	-.2391+01	.1160+01	-.2391+01	.1136+01	-.2391+01	.1112+01
41	.1088+01	-.2392+01	.0000	-.2392+01	.0000	-.2392+01	.0000	-.2392+01	.0000
SEGMENT 2		SEGMENT 3		SEGMENT 4		SEGMENT 5		SEGMENT 1	
1	.1088+01	-.2392+01	.1064+01	-.2392+01	.1040+01	-.2392+01	.1016+01	-.2392+01	.9926+00
11	.9686+00	-.2392+01	.9447+00	-.2391+01	.9208+00	-.2391+01	.8949+00	-.2392+01	.8730+00
21	.8491+00	-.2393+01	.8251+00	-.2393+01	.8012+00	-.2393+01	.7773+00	-.2393+01	.7533+00
31	.7294+00	-.2393+01	.7056+00	-.2393+01	.6816+00	-.2393+01	.6576+00	-.2393+01	.6337+00
41	.6898+00	-.2393+01	.0000	-.2393+01	.0000	-.2393+01	.0000	-.2393+01	.0000
SEGMENT 3		SEGMENT 4		SEGMENT 5		SEGMENT 1		SEGMENT 2	
1	.6898+00	-.2393+01	.5858+00	-.2393+01	.5619+00	-.2393+01	.5380+00	-.2393+01	.5140+00
11	.4901+00	-.2392+01	.4662+00	-.2392+01	.4423+00	-.2392+01	.4183+00	-.2392+01	.3944+00
21	.3705+00	-.2392+01	.3468+00	-.2392+01	.3226+00	-.2393+01	.2987+00	-.2393+01	.2748+00
31	.2609+00	-.2393+01	.2269+00	-.2393+01	.2030+00	-.2393+01	.1791+00	-.2393+01	.1551+00
41	.1812+00	-.2393+01	.0000	-.2393+01	.0000	-.2393+01	.0000	-.2393+01	.0000
SEGMENT 4		SEGMENT 5		SEGMENT 1		SEGMENT 2		SEGMENT 3	
1	.1312+00	-.2393+01	.1073+00	-.2393+01	.0833+00	-.2392+01	.5945+01	-.2392+01	.3553+01
11	.1161+01	-.2392+01	.1238+01	-.2391+01	.1362+01	-.2391+01	.6012+01	-.2391+01	.4030+01
21	.1079+00	-.2391+01	.1318+00	-.2391+01	.1558+00	-.2391+01	.1797+00	-.2391+01	.2036+00
31	.12275+00	-.2391+01	.2514+00	-.2391+01	.2753+00	-.2391+01	.2992+00	-.2391+01	.3231+00
41	.34670+00	-.2391+01	.0000	-.2391+01	.0000	-.2391+01	.0000	-.2391+01	.0000
SEGMENT 5		SEGMENT 1		SEGMENT 2		SEGMENT 3		SEGMENT 4	
1	.2470+00	-.2391+01	.3709+00	-.2391+01	.3948+00	-.2391+01	.4187+00	-.2390+01	.4424+00
11	.1645+00	-.2389+01	.4904+00	-.2389+01	.5143+00	-.2389+01	.5382+00	-.2388+01	.5621+00
21	.5860+00	-.2388+01	.6098+00	-.2388+01	.6337+00	-.2388+01	.6576+00	-.2388+01	.6815+00
31	.7054+00	-.2388+01	.7292+00	-.2388+01	.7531+00	-.2388+01	.7770+00	-.2388+01	.8009+00
41	.8247+00	-.2388+01	.0000	-.2388+01	.0000	-.2388+01	.0000	-.2388+01	.0000

NORMAL FREQUENCY = .2448000 CPS									
MODE NO. 3		MODE NO. 1		MODE NO. 2		MODE NO. 4		MODE NO. 5	
SEGMENT 1	-.1569+01	.7275+01	-.1496+01	.7277+01	-.1424+01	.7273+01	-.1351+01	.7273+01	-.1278+01
1	-.1206+01	.7260+01	-.1333+01	.7248+01	-.1061+01	.7232+01	-.9865+00	.7213+01	-.9465+00
11	-.8448+00	.7160+01	-.7734+00	.7120+01	-.7023+00	.7082+01	-.6318+00	.7028+01	-.5617+00
21	-.4923+00	.6908+01	-.4235+00	.6843+01	-.3565+00	.6756+01	-.2884+00	.6675+01	-.2221+00
31	-.1569+00	.6479+01	.0000	.6479+01	.0000	.6479+01	.0000	.6479+01	.0000
SEGMENT 2	-.1569+00	.6479+01	-.9255+01	.6383+01	-.2938+01	.6249+01	-.1351+01	.7273+01	-.1278+01
1	-.1522+00	.5841+01	-.2098+00	.5677+01	-.2658+00	.5517+01	-.1061+01	.3201+00	-.3724+00
11	-.4232+00	.4973+01	-.4720+00	.4771+01	-.5187+00	.5087+01	-.4354+01	.5633+00	-.4146+01
21	-.6461+00	.3905+01	-.6841+00	.3690+01	-.7197+00	.3433+01	-.7529+00	.3209+01	-.7837+00
31	-.8118+00	.2716+01	.0000	.8118+00	.0000	.8118+00	.0000	.8118+00	.0000
SEGMENT 3	-.1569+00	.8118+00	-.2716+01	.8380+00	-.2489+01	.8614+00	-.2205+01	.8821+00	-.1961+01
1	.9159+00	.1415+01	.9286+00	.1123+01	.9385+00	.8594+02	.9456+00	.5706+02	.9500+00
11	.9515+00	.1358+03	.9502+00	.12692+02	.9462+00	.8443+02	.9393+00	.8323+02	.9296+00
21	.9172+00	.1389+01	.9021+00	.1643+01	.8842+00	.1935+01	.8636+00	.2179+01	.8404+00
31	.8144+00	.2692+01	.0000	.8144+00	.0000	.8144+00	.0000	.8144+00	.0000
SEGMENT 4	.8144+00	.2692+01	.7865+00	.2918+01	.3185+01	.7230+00	.3410+01	.6876+00	.34667+01
1	.6499+00	.3682+01	.6099+00	.4123+01	.5330+01	.5232+00	.4330+01	.4767+00	.4750+01
11	.4281+00	.4953+01	.3777+00	.5141+01	.3253+00	.5323+01	.2712+00	.2154+00	.5646+01
21	.1580+00	.5826+01	.9899+01	.5964+01	.8658+01	.6117+01	.2319+01	.6622+01	.6370+01

5-SEG MODAL SYNTHESIS FOR BEAM

TABLE II. Non-ideal frequency response.

SEGMENT		1	2	3	4	5
1	1	+1671+01	+1231+00	+1448+01	+1232+00	+1235+01
1	11	+9567+00	+1220+00	+8351+00	+1212+00	+1244+00
2	21	+3609+00	+1151+00	+2470+00	+1125+00	+1357+00
3	31	+1789+00	+9109-01	+2760+00	+9167+01	+3687+00
4	41	+6161+00	+7465+01	+8000	+8000	+9010-01
SEGMENT		1	2	3	4	5
1	1	+6161+00	+7465+01	+6884+00	+6935+01	+7544+00
1	11	+9532+00	+4288+01	+9523+00	+3542+01	+9843+00
2	21	+1037+01	+6417+02	+1037+01	+1034+03	+1035+01
3	31	+9789+00	+2912+01	+9467+00	+3525+01	+9081+00
4	41	+7568+00	+5810+01	+8000	+8000	+9000
SEGMENT		1	2	3	4	5
1	1	+7568+00	+5810+01	+6967+00	+6967+01	+6967+00
1	11	+4140+00	+7731+01	+3352+00	+8002+01	+2544+00
2	21	+3802+02	+8451+01	+8001+01	+8400+01	+1643+00
3	31	+4069+00	+7753+01	+4832+00	+7484+01	+5562+00
4	41	+7513+00	+5853+01	+8000	+8000	+8000
SEGMENT		1	2	3	4	5
1	1	+7513+00	+5853+01	+8079+00	+5397+01	+8589+00
1	11	+9762+00	+2977+01	+1002+01	+2270+01	+1022+01
2	21	+1837+01	+5658+02	+1028+01	+1306+01	+1010+01
3	31	+9178+00	+4216+01	+8723+00	+4870+01	+8200+00
4	41	+6238+00	+7411+01	+8000	+8000	+8000
SEGMENT		1	2	3	4	5
1	1	+6238+00	+7411+01	+8498+00	+7925+01	+4653+00
1	11	+1870+00	+9867+01	+1030+00	+8814+01	+1030+00
2	21	+3489+00	+1148+00	+4647+00	+5824+00	+1167+00
3	31	+9433+00	+1217+00	+1065+01	+1222+00	+1218+01
4	41	+1556+01	+1228+00	+8000	+8000	+8000

NORMAL FREQUENCY = 1338401 CPS

## 5-SEG MODAL SYNTHESIS FOR BEAM

SEGMENT	3	4	5	6	7	8	9	DATE 07/13/70	PAGE
1	.5063+0.00	.1078+0.00	.6116+0.00	.1020+0.00	.7096+0.00	.9375+0.01	.7992+0.00	.8533+0.01	10
11	.9491+0.00	.4437+0.1	.1002+0.1	.5229+0.1	.1054+0.1	.4025+0.1	.1066+0.1	.2717+0.1	20
21	.1116+0.1	.7121+0.3	.1110+0.1	.1272+0.1	.1090+0.1	.2581+0.1	.1058+0.1	.3896+0.1	30
31	.9556+0.00	.6633+0.01	.8861+0.00	.7390+0.01	.8076+0.00	.8455+0.01	.7186+0.00	.9313+0.01	40
41	.5162+0.00	.1076+0.00	.0000	.0000	.0000	.0000	.0000	.0000	50
SEGMENT	4	5	6	7	8	9	10	11	12
1	.5162+0.00	.1076+0.00	.4064+0.00	.1127+0.00	.2915+0.00	.1167+0.00	.1735+0.00	.1191+0.00	.5373+0.01
11	.6632+0.01	.1196+0.00	.1852+0.00	.1179+0.00	.3013+0.00	.1141+0.00	.413+0.00	.1096+0.00	.1029+0.00
21	.6190+0.00	.9573+0.1	.7102+0.00	.6633+0.01	.7919+0.00	.7695+0.01	.831+0.00	.6525+0.01	.9228+0.00
31	.9101+0.00	.4056+0.1	.1004+0.1	.2003+0.1	.1025+0.1	.1336+0.1	.1032+0.1	.3467+0.1	.1025+0.01
41	.1002+0.1	.2810+0.1	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SEGMENT	5	6	7	8	9	10	11	12	13
1	.1802+0.1	.2810+0.1	.7684+0.00	.4095+0.1	.9200+0.00	.5576+0.01	.8579+0.00	.6838+0.01	.7825+0.00
11	.6943+0.00	.9390+0.1	.5941+0.00	.1064+0.00	.4826+0.00	.1165+0.00	.3608+0.00	.1270+0.00	.2295+0.00
21	.8994+0.01	.1436+0.00	.5707+0.01	.1502+0.00	.2103+0.00	.1561+0.00	.3688+0.00	.1608+0.00	.1645+0.00
31	.6476+0.00	.1675+0.00	.8460+0.00	.1693+0.00	.0323+0.01	.1708+0.00	.1207+0.1	.1712+0.00	.1718+0.00
41	.1550+0.1	.1715+0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000

## NORMAL FREQUENCY = .2213401 CPS

SEGMENT	1	2	3	4	5	6	7	8	9
1	.1392+0.1	.2253+0.00	.1366+0.1	.2257+0.00	.1141+0.1	.2244+0.0	.9173+0.0	.2229+0.0	.4961+0.00
11	.4792+0.00	.2191+0.00	.2687+0.0	.2067+0.00	.6662+0.1	.1971+0.0	.1249+0.0	.1034+0.0	.1714+0.00
21	.4467+0.00	.1563+0.00	.9121+0.00	.1364+0.00	.7316+0.00	.1171+0.0	.956+0.0	.9453+0.01	.7294+0.00
31	.9100+0.00	.4814+0.1	.1027+0.1	.2541+0.1	.1040+0.1	.4268+0.1	.1028+0.1	.2230+0.01	.9939+0.00
41	.9365+0.00	.4997+0.1	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SEGMENT	2	3	4	5	6	7	8	9	10
1	.7365+0.00	.6597+0.1	.6423+0.00	.8448+0.01	.7482+0.00	.1324+0.0	.6575+0.00	.1321+0.00	.1322+0.00
11	.3681+0.00	.1415+0.00	.2491+0.00	.1494+0.00	.9735+0.01	.1531+0.0	.5705+0.1	.1552+0.00	.2104+0.00
21	.3610+0.00	.1877+0.00	.5042+0.00	.1813+0.00	.6376+0.00	.1282+0.0	.7584+0.0	.1133+0.00	.1819+0.00
31	.9532+0.00	.7896+0.01	.1023+0.01	.6028+0.01	.1072+0.01	.3818+0.01	.1100+0.1	.1739+0.01	.5555+0.02
41	.1089+0.01	.2603+0.01	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SEGMENT	3	4	5	6	7	8	9	10	11
1	.1088+0.01	.2440+0.01	.1058+0.01	.4600+0.01	.4997+0.00	.4059+0.02	.1093+0.1	.6735+0.01	.9257+0.00
11	.7142+0.00	.1185+0.00	.8894+0.00	.1327+0.00	.9829+0.0	.1420+0.0	.3043+0.0	.1505+0.00	.1540+0.00
21	.9737+0.02	.1865+0.00	.1571+0.00	.1537+0.00	.3112+0.00	.1500+0.00	.9570+0.0	.1420+0.00	.9822+0.01
31	.3941+0.00	.1395+0.00	.6281+0.00	.1027+0.00	.8921+0.00	.8398+0.01	.6667+0.0	.1054+0.00	.5555+0.02
41	.9268+0.00	.4474+0.01	.2640+0.01	.0000	.0000	.0000	.0000	.0000	.0000
SEGMENT	4	5	6	7	8	9	10	11	12
1	.9268+0.00	.6474+0.1	.7832+0.00	.4548+0.01	.1017+0.1	.2186+0.1	.1028+0.1	.7345+0.0	.5555+0.04
11	.9795+0.00	.4709+0.01	.9202+0.00	.7135+0.01	.8382+0.00	.7254+0.01	.1145+0.0	.1145+0.00	.1334+0.00
21	.9677+0.00	.1518+0.00	.3080+0.00	.1672+0.00	.1334+0.00	.1813+0.00	.5340+0.01	.1927+0.00	.2020+0.00
31	.4869+0.00	.2093+0.00	.6688+0.00	.2141+0.00	.8849+0.00	.2178+0.00	.1104+0.1	.2192+0.00	.2220+0.00
41	.1544+0.01	.2201+0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000

SEGMENT 1 MODE NO. 7

NORMAL FREQUENCY # .3281+01 CPS

SEGMENT 1

EXAMPLE 2: Four ATM solar arrays (96 DOF's each) are connected radially to an ATM rack (51 DOF's). All five segments are considered as free-free subsystems, and have their individual subsystem modes (including 6 rigid body modes for each segment) given<sup>(5)</sup> by the same tape (designated as unit #1) in a specified record position. Each solar array is connected to the rack at one modal point, which has six DOF's. Thus each solar array has six properly numbered interface constraints with the rack, and the rack has 24 constraints with all four solar arrays. The constraints are numbered from 1 to 24 and their corresponding numbers of DOF's with their adjacent segments are specified in the input.

To compute the modes (say the lowest 20) of the overall system select certain subsystem modes having compatible magnitudes (say the lowest 30 modes from each solar array and the lowest 15 modes from the rack), and perform modal synthesis. See Table 3 for input, portions of the output are also attached. Notice that the overall system has 411 DOF's, which is generally considered as too big a system to obtain a direct eigensolution with accuracy and efficiency. The synthesis portion only cost 284 charge units. In addition, the frequencies of the 6 rigid body modes are distinctly separated from the lowest elastic modes, and certain nearly repeated frequencies caused by geometric symmetry occur, which are considered as good signs of accuracy.

TABLE 3

INPUT FOR MODAL SYNTHESIS OF  
4 ATM SOLAR ARRAYS AND RACK

\$INPUT\*

```

NCASE = 2,
NTS = 5, NV = 20,
ND = 96, 96, 96, 96, 51,
NMP = 96, 96, 96, 96, 51,
NMQ = 30, 30, 30, 30, 15,
NML = 7, 7, 7, 7, 7,
NTR = 24, NR = 6, 6, 6, 6, 24,
NRD = 1, 91, 2, 92, 3, 93, 4, 94, 5, 95, 6, 96,
      7, 91, 8, 92, 9, 93, 10, 94, 11, 95, 12, 96,
      13, 91, 14, 92, 15, 93, 16, 94, 17, 95, 18, 96,
      19, 91, 20, 92, 21, 93, 22, 94, 23, 95, 24, 96,
      1, 28, 2, 29, 3, 30, 4, 31, 5, 32, 6, 33,
      7, 34, 8, 35, 9, 36, 10, 37, 11, 38, 12, 39,
      13, 40, 14, 41, 15, 42, 16, 43, 17, 44, 18, 45,
      19, 46, 20, 47, 21, 48, 22, 49, 23, 50, 24, 51,
NRG = 6, 6, 6, 6, 6,
NRGSQ = 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 6,
NTAPE = 1, 1, 1, 1, 1,
NREC = 3, 1, 1, 1, 1,
NRECRB = 0, 0, 0, 0, 0,
$END

```

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

## MODAL SYNTHESIS

DATE 091470

PAGE 4

NO. OF SEGMENTS = 6  
 NO. OF INTERFACE RESTRAINTS = 24  
 NO. OF DOF OF OVERALL SYSTEM = 414

## FOR SEGMENT NO. 1

NO. OF DOF = 96

NO. OF MODES AVAILABLE = 96

NO. OF MODES USED IN SYNTHESIS = 30 WHICH INCLUDES

6 RIGID BODY MODES   (START MODE NO. 7)  
24 ELASTIC MODES

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 6

RESTRAINT NO.   1   2   3   4   5   6  
DOF NO.       91   92   93   94   95   96

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
RECORD POSITION NO. = 3  
RIGID BODY MODE NOS. = 1   2   3   4   5   6

## FOR SEGMENT NO. 2

NO. OF DOF = 96

NO. OF MODES AVAILABLE = 96

NO. OF MODES USED IN SYNTHESIS = 30 WHICH INCLUDES

6 RIGID BODY MODES   (START MODE NO. 7)  
24 ELASTIC MODESNO. OF RESTRAINTS TO ADJACENT SEGMENTS = 6  
RESTRAINT NO.   7   8   9   10   11   12  
DOF NO.       91   92   93   94   95   96

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
RECORD POSITION NO. = 1  
RIGID BODY MODE NOS. = 1   2   3   4   5   6

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

DATE 091470

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## FOR SEGMENT NO. 3

NO. OF DOF = 96

NO. OF MODES AVAILABLE = 96

NO. OF MODES USED IN SYNTHESIS = 30 WHICH INCLUDES

6 RIGID BODY MODES  
24 ELASTIC MODES (START MODE NO. 7)

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 6

RESTRAINT NO.	13	14	15	16	17	18
DOF NO.	91	92	93	94	95	96

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1
RECORD POSITION NO. = 1
RIGID BODY MODE NOS. = 1 2 3 4 5 6

## FOR SEGMENT NO. 4

NO. OF DOF = 96

NO. OF MODES AVAILABLE = 96

NO. OF MODES USED IN SYNTHESIS = 30 WHICH INCLUDES

6 RIGID BODY MODES  
24 ELASTIC MODES (START MODE NO. 7)

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 6

RESTRAINT NO.	19	20	21	22	23	24
DOF NO.	91	92	93	94	95	96

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1
RECORD POSITION NO. = 1
RIGID BODY MODE NOS. = 1 2 3 4 5 6

## FOR SEGMENT NO. 5

NO. OF DOF = 51

NO. OF MODES AVAILABLE = 51

NO. OF MODES USED IN SYNTHESIS = 15 WHICH INCLUDES

6 RIGID BODY MODES  
9 ELASTIC MODES (START MODE NO. 7)

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

NO. OF RESTRAINTS TO ADJACENT SEGMENTS = 24

RESTRAINT NO.	1	2	3	4	5	6
DOF NO.	28	29	30	31	32	33

## STORAGE OF SEGMENT MODES

TAPE UNIT NO. = 1  
 RECORD POSITION NO. = 1  
 RIGID BODY MODE NOS. = 1 2 3 4 5 6

## TRANSFORMATION MATRIX

ROW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	.5043-02	.1779-02	.7257-02	.1258-01	.2375-03	.7130-02	.8058-02	.1109-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
11	.0000	.2931-01	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
21	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
31	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
41	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
51	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
61	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
71	.4692-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	.6667-01	
81	.00121-02	.2706-02	.3325-02	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	.4778-03	
91	.002477-02	.1130-03	.5510-03	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	.7698-02	
101	.01434+00	.7595-02	.5368-01	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	.2409+00	
111	.003644-01	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
121	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
131	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
141	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
151	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
161	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
171	.002086-01	.3321-01	.4000-03	.5676-03	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	.6245-02	
181	.005576-01	.1346-02	.1655-02	.2377-03	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00	.5140+00
191	.001083-02	.5622-04	.2274-03	.3830-02	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03	.7633-03
201	.001479+00	.1626-01	.1695+00	.1962-01	.1072+00	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01	.8885-01
211	.0007065+00	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
221	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
231	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
241	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
251	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
261	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	

DATE 091470

PAGE 6

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

PAGE 42

DATE 091470

## PSEUDO MASS MATRIX

## PSEUDO MASS MATRIX

ROW	1	2	3	
1	.1013+01 .3914-01 .7235-02 .6612-03 .1915-01 .316-02 .2444-03 .3835-02 .3801-03 .3894-03 .2038-01 .3634-01	.9842+02 .3045-01 .2646-02 .2210-01 .4248-02 .1048-02 .8102-02 .1284-03 .3531-02 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.4935-02 .2646-02 .3694-02 .3439-02 .3433-02 .1591-02 .1016-01 .1597-02 .1284-03 .3123-03 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1214-01 .4806-02 .3696-01 .5971-03 .5264-02 .1832-03 .1597-02 .1310-01 .1149-04 .2126-02 .1121-03 .1106-03 .1106-03 .1571-01 .1731-01 .0000 .0000
2	.9842-02 .22031-02 .3755-03 .3280-04 .7244-03 .1721-03 .6663-05 .1476-04 .1819-02 .3749-04 .6212-04 .1101-01 .44435-01	.1008+01 .3694-01 .9154-03 .2911-04 .1558-01 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.6718-02 .1373-03 .1117-02 .2205-03 .5396-04 .5273-03 .2984-01 .8288-04 .1230-03 .1121-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1210-01 .2053-03 .1785-03 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01
3	.4935-02 .2629+00 .4463-02 .1831-02 .1648-03 .3561-02 .8391-03 .7198-04 .1389-01 .44213-03 .7644-03 .3736-01	.6718-02 .6677-03 .5592-02 .1419-03 .1110+00 .2631-03 .4041-03 .3249-04 .2146-01 .1014-02 .7761-04 .3095-01	.1057+01 .1001-02 .8704-03 .1075-02 .2631-03 .2631-03 .4041-03 .4993-03 .3268-03 .1014-02 .2274-03 .2400-02 .3780-01 .8594-01	.1495-01 .1216-02 .3907-02 .1511-03 .4025-03 .2631-03 .4041-03 .4993-03 .3268-03 .1014-02 .2274-03 .2400-02 .3780-01 .8594-01
4	.1013+01 .3914-01 .7235-02 .6612-03 .1915-01 .316-02 .2444-03 .3835-02 .3801-03 .3894-03 .2038-01 .3634-01	.9842+02 .3045-01 .2646-02 .2210-01 .4248-02 .1048-02 .8102-02 .1284-03 .3123-03 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1214-01 .4806-02 .3696-01 .5971-03 .5264-02 .1832-03 .1597-02 .1310-01 .1149-04 .2126-02 .1121-03 .1106-03 .1106-03 .1571-01 .1731-01 .0000 .0000	.1147-01 .2401-02 .2350-01 .1669-02 .1553-02 .1013+00 .1076-01 .1566-04 .051-01 .1575-02 .1013-02 .2322-03 .1261-02 .1261-02 .1050-01 .1050-01 .0000 .0000
5	.9842-02 .22031-02 .3755-03 .3280-04 .7244-03 .1721-03 .6663-05 .1476-04 .1819-02 .3749-04 .6212-04 .1101-01 .44435-01	.1008+01 .3694-01 .9154-03 .2911-04 .1558-01 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.6718-02 .1373-03 .1117-02 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.1210-01 .2053-03 .1785-03 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01
6	.1013+01 .3914-01 .7235-02 .6612-03 .1915-01 .316-02 .2444-03 .3835-02 .3801-03 .3894-03 .2038-01 .3634-01	.9842+02 .3045-01 .2646-02 .2210-01 .4248-02 .1048-02 .8102-02 .1284-03 .3123-03 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1214-01 .4806-02 .3696-01 .5971-03 .5264-02 .1832-03 .1597-02 .1310-01 .1149-04 .2126-02 .1121-03 .1106-03 .1106-03 .1571-01 .1731-01 .0000 .0000	.1147-01 .2401-02 .2350-01 .1669-02 .1553-02 .1013+00 .1076-01 .1566-04 .051-01 .1575-02 .1013-02 .2322-03 .1261-02 .1261-02 .1050-01 .1050-01 .0000 .0000
7	.9842-02 .22031-02 .3755-03 .3280-04 .7244-03 .1721-03 .6663-05 .1476-04 .1819-02 .3749-04 .6212-04 .1101-01 .44435-01	.1008+01 .3694-01 .9154-03 .2911-04 .1558-01 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.6718-02 .1373-03 .1117-02 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.1210-01 .2053-03 .1785-03 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01
8	.1013+01 .3914-01 .7235-02 .6612-03 .1915-01 .316-02 .2444-03 .3835-02 .3801-03 .3894-03 .2038-01 .3634-01	.9842+02 .3045-01 .2646-02 .2210-01 .4248-02 .1048-02 .8102-02 .1284-03 .3123-03 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1214-01 .4806-02 .3696-01 .5971-03 .5264-02 .1832-03 .1597-02 .1310-01 .1149-04 .2126-02 .1121-03 .1106-03 .1106-03 .1571-01 .1731-01 .0000 .0000	.1147-01 .2401-02 .2350-01 .1669-02 .1553-02 .1013+00 .1076-01 .1566-04 .051-01 .1575-02 .1013-02 .2322-03 .1261-02 .1261-02 .1050-01 .1050-01 .0000 .0000
9	.9842-02 .22031-02 .3755-03 .3280-04 .7244-03 .1721-03 .6663-05 .1476-04 .1819-02 .3749-04 .6212-04 .1101-01 .44435-01	.1008+01 .3694-01 .9154-03 .2911-04 .1558-01 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.6718-02 .1373-03 .1117-02 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01	.1210-01 .2053-03 .1785-03 .2205-03 .5396-04 .4205-03 .1024-03 .4492-02 .3194-03 .8987-04 .10928-04 .3981-02 .44435-01
10	.1013+01 .3914-01 .7235-02 .6612-03 .1915-01 .316-02 .2444-03 .3835-02 .3801-03 .3894-03 .2038-01 .3634-01	.9842+02 .3045-01 .2646-02 .2210-01 .4248-02 .1048-02 .8102-02 .1284-03 .3123-03 .7122-03 .8556-03 .2276-03 .1106-03 .4291-02 .2520-02 .0000 .0000	.1214-01 .4806-02 .3696-01 .5971-03 .5264-02 .1832-03 .1597-02 .1310-01 .1149-04 .2126-02 .1121-03 .1106-03 .1106-03 .1571-01 .1731-01 .0000 .0000	.1147-01 .2401-02 .2350-01 .1669-02 .1553-02 .1013+00 .1076-01 .1566-04 .051-01 .1575-02 .1013-02 .2322-03 .1261-02 .1261-02 .1050-01 .1050-01 .0000 .0000

MULTI SEGMENT MORAL SYNTHESIS FOR AIM ARRAYS AND BACK

PSUEDO STIFFNESS MATRIX

ROW	2	$\cdot 3301 \pm 04$	$\cdot 1143 \pm 01$	$\cdot 2273 \pm 02$	$\cdot 3116 \pm 01$	$\cdot 1418 \pm 01$	$\cdot 4051 \pm 00$	$\cdot 2023 \pm 01$	$\cdot 6603 \pm 01$	$\cdot 1140 \pm 01$
1	$\cdot 1455 \pm 02$									
1.1	$\cdot 3669 \pm 01$	$\cdot 5068 \pm 01$	$\cdot 1226 \pm 01$	$\cdot -1415 \pm 01$	$\cdot 5224 \pm 01$	$\cdot -2494 \pm 01$	$\cdot 4359 \pm 01$	$\cdot 1275 \pm 01$	$\cdot -2927 \pm 01$	$\cdot -2792 \pm 01$
2.1	$\cdot -2443 \pm 01$	$\cdot -6182 \pm 01$	$\cdot 8018 \pm 01$	$\cdot 1459 \pm 01$	$\cdot -4580 \pm 02$	$\cdot 9106 \pm 01$	$\cdot -7639 \pm 01$	$\cdot 7428 \pm 02$	$\cdot 6614 \pm 01$	$\cdot 2952 \pm 01$
3.1	$\cdot 9703 \pm 02$	$\cdot 8550 \pm 02$	$\cdot -1102 \pm 01$	$\cdot -1463 \pm 01$	$\cdot -965 \pm 02$	$\cdot 2358 \pm 01$	$\cdot -1937 \pm 01$	$\cdot 7104 \pm 01$	$\cdot 9033 \pm 01$	$\cdot -5726 \pm 01$
4.1	$\cdot -2025 \pm 01$	$\cdot 2207 \pm 01$	$\cdot -7199 \pm 02$	$\cdot 8220 \pm 02$	$\cdot -7035 \pm 02$	$\cdot -4808 \pm 02$	$\cdot -4599 \pm 01$	$\cdot 5783 \pm 01$	$\cdot 1154 \pm 03$	$\cdot 3855 \pm 01$
5.1	$\cdot 1191 \pm 01$	$\cdot 3043 \pm 01$	$\cdot -3854 \pm 01$	$\cdot -7041 \pm 01$	$\cdot -7035 \pm 02$	$\cdot -4808 \pm 02$	$\cdot -4599 \pm 01$	$\cdot 5791 \pm 01$	$\cdot 8101 \pm 02$	$\cdot -3672 \pm 01$
6.1	$\cdot 1144 \pm 01$	$\cdot 8146 \pm 02$	$\cdot 7752 \pm 02$	$\cdot -1793 \pm 01$	$\cdot 9281 \pm 02$	$\cdot -1212 \pm 01$	$\cdot 7201 \pm 02$	$\cdot 6139 \pm 01$	$\cdot -2019 \pm 01$	$\cdot -1466 \pm 01$
										$\cdot 8785 \pm 02$

## MODAL SYNTHESIS RESULTS

## LIST OF FREQUENCIES (CPS)

*59604-04	*61666-04	*78057-04	*96764-04	*24733-03	*54573-03	*33306+00	*34344+00	*46592+00	*46891+00
*61999+00	*62007+00	*62166+00	*62242+00	*64925+00	*66526+00	*75891+00	*78957+00	*99884+00	*99884+00
*10611+01	*10911+01	*14781+01	*14867+01	*15176+01	*15506+01	*18164+01	*18206+01	*18211+01	*18211+01
*29519+01	*29532+01	*29532+01	*29532+01	*30767+01	*30866+01	*31037+01	*31793+01	*33171+01	*33174+01
*33174+01	*33184+01	*33962U+01	*40486+01	*4630R+01	*46330+01	*46339+01	*46362+01	*47601+01	*49052+01
*49296+01	*49401+01	*49417+01	*51961+01	*51967+01	*52078+01	*52231+01	*61245+01	*61950+01	*62044+01
*62206+01	*62851+01	*63279+01	*63309+01	*63420+01	*64236+01	*69185+01	*73683+01	*73700+01	*73712+01
*73746+01	*77719+01	*77721+01	*77721+01	*77723+01	*80470+01	*80681+01	*80689+01	*80731+01	*80954+01
*85221+01	*85222+01	*85222+01	*87114+01	*87117+01	*87129+01	*87149+01	*87160+01	*91157+01	*91157+01
*91173+01	*91236+01	*91241+01	*91243+01	*91244+01	*94246+01	*91598+01	*92362+01	*92837+01	*93637+01
*93731+01	*94382+01	*94408+01	*94412+01	*94448+01	*94665+02	*10665+02	*10668+02	*10668+02	*23569+02
*26748+02									

## MODE NO. 1 NORMAL FREQUENCY • 5960-04 CPS

SEGMENT	1	2	3	4	5	6	7	8	9	10
1	-*9045-01	-*5079-01	-*5472-01	-*8649-01	-*4810-01	-*5125-01	-*96442-01	-*5146-01	-*7743-01	-*9310-01
1.1	-*4914-01	-*8007-01	-*8978-01	-*4482-01	-*8271-01	-*9314-01	-*5475-01	-*4596-01	-*9968-01	-*4820-01
2	-*1087+00	-*9304-01	-*4156-01	-*1140+00	-*9700-01	-*4424-01	-*1175+00	-*1029+00	-*1399+00	-*1399+00
3	-*9962-01	-*4162-01	-*4126+00	-*9630-01	-*3830-01	-*1452+00	-*1062+00	-*4168-01	-*1712+00	-*9956-01
4	-*3504-01	-*1765+00	-*1035+00	-*3774-01	-*1798+00	-*1095+00	-*3842-01	-*2025+00	-*1061+00	-*3510-01
5	-*2051+00	-*1028+00	-*3178-01	-*2077+00	-*1127+00	-*3516-01	-*2337+00	-*1061+00	-*2852-01	-*2390+00
6	-*11100+00	-*3120-01	-*2425+00	-*1160+00	-*3190-01	-*2650+00	-*1127+00	-*2858-01	-*1093+00	-*1093+00
7	-*2526-01	-*2703+00	-*1192+00	-*2864-01	-*2962+00	-*1126+00	-*2200-01	-*3015+00	-*1466+00	-*2468-01
8	-*3050+00	-*1225+00	-*2538-01	-*3275+00	-*1192+00	-*2206-01	-*3301+00	-*1159+00	-*1874-01	-*3328+00
9	-*8370-01	-*5232-01	-*1708-01	-*4712-03	-*3989-03	-*9077-04	-*.0000	-*.0000	-*.0000	-*.0000
SEGMENT	2	3	4	5	6	7	8	9	10	
1	-*8480-01	-*6552-01	-*7151-01	-*8748-01	-*6157-01	-*3916-01	-*8412-01	-*7149-01	-*1055+00	-*8744-01
1.1	-*6817-01	-*7362-01	-*9076-01	-*6485-01	-*4177-01	-*8084-01	-*6821-01	-*1028+00	-*8738-01	-*7475-01
2	-*1081+00	-*9402-01	-*6811-01	-*4437-01	-*9135-01	-*7207-01	-*7673-01	-*9064-01	-*7801-01	-*1107+00
3	-*9396-01	-*7469-01	-*7882-01	-*9729-01	-*7137-01	-*4698-01	-*939U-01	-*8127-01	-*1133+00	-*1005+00
4	-*7463-01	-*4967-01	-*9785-01	-*7858-01	-*8192-01	-*9716-01	-*8453-01	-*1159+00	-*1005+00	-*8121-01
5	-*8902-01	-*1038+00	-*7879-01	-*5218-01	-*1004+00	-*8779-01	-*1184+00	-*1071+00	-*8115-01	-*5476-01
6	-*1044+00	-*8511-01	-*8712-01	-*1037+00	-*9105-01	-*1210+00	-*1074+00	-*8773-01	-*8920-01	-*1103+00
7	-*8441-01	-*5736-01	-*1069+00	-*9431-01	-*1236+00	-*1136+00	-*8767-01	-*5995-01	-*9163-01	-*9163-01
8	-*9231-01	-*11020-00	-*9757-01	-*1262+00	-*1135+00	-*9425-00	-*9439-01	-*1168+00	-*9093-01	-*6255-01
9	-*8370-01	-*6399-01	-*6839-01	-*4712-03	-*3989-03	-*9077-04	-*.0000	-*.0000	-*.0000	-*.0000
SEGMENT	3	4	5	6	7	8	9	10		
1	-*8844-01	-*6448-01	-*2521-01	-*9240-01	-*6716-01	-*2174-01	-*8247-01	-*6380-01	-*4791-01	-*8579-01
1.1	-*6712-01	-*5056-01	-*8912-01	-*7044-01	-*5321-01	-*6052-01	-*645-01	-*7021-01	-*6706-01	-*7021-01
2	-*7916-01	-*8585-01	-*7370-01	-*8446-01	-*8189-01	-*7102-01	-*8799-01	-*7359-01	-*7032-01	-*1104+00
3	-*7927-01	-*7364-01	-*1131+00	-*8429-01	-*7696-01	-*1157+00	-*7269-01	-*7358-01	-*7417+00	-*7933-01
4	-*8022-01	-*1470+00	-*7539-01	-*7553-01	-*1503+00	-*6943-01	-*7684-01	-*1729+00	-*7275-01	-*8016-01
5	-*1756+00	-*7607-01	-*8348-01	-*1782+00	-*6617-01	-*8010-01	-*2042+00	-*7281-01	-*8674-01	-*2095+00
6	-*6885-01	-*8406-01	-*2130+00	-*6291-01	-*8336-01	-*6662-01	-*2355+00	-*6668-01	-*2381+00	-*6955-01
7	-*9000-01	-*2407+00	-*5965-01	-*2667+00	-*5971-01	-*9320-01	-*3006+00	-*6303-01	-*9058-01	-*9058-01
8	-*2755+00	-*5639-01	-*8988-01	-*2980+00	-*5971-01	-*9320-01	-*3000+00	-*6303-01	-*9652-01	-*3033+00

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

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SEGMENT	4	91	-0.8954-01	-0.5816-01	-0.1243-U1	0.4712-U3	-0.3989-U3	0.9077-U4	0.0000	0.0000	0.0000	100	
1	-0.7111-01	-0.5184-01	-0.6990-01	-0.6843-U1	-0.5579-01	-0.1023+00	-0.7179-U1	-0.4587-U1	-0.3595-01	-0.6847-01	1.0		
11	-0.4919-01	-0.6779-01	-0.6514-01	-0.5251-U1	-0.9964-01	-0.7507-01	-0.4915-01	-0.3857-01	-0.6853-01	-0.4261-01	20		
21	-0.3336-01	-0.6188-01	-0.4928-01	-0.9705-U1	-0.6456-01	-0.4529-01	-0.6469-01	-0.6527-01	-0.3935-01	-0.3078-01	30		
31	-0.6195-01	-0.4267-01	-0.6262-01	-0.6862-U1	-0.4599-01	-0.9446-01	-0.6201-01	-0.3609-01	-0.2817-01	-0.5536-01	40		
41	-0.4273-01	-0.9185-01	-0.5806-01	-0.3678-U1	-0.5951-01	-0.5875-01	-0.3283-01	-0.2557-01	-0.5542-01	-0.3615-01	50		
51	-0.5740-01	-0.5210-01	-0.3947-U1	-0.8924-U1	-0.5549-01	-0.2957-01	-0.2297-01	-0.4884-01	-0.3621-01	-0.8665-01	60		
61	-0.5152-01	-0.3225-01	-0.5430-01	-0.5222-01	-0.2631-01	-0.2037-01	-0.4890-U1	-0.2963-01	-0.5221-01	-0.4558-01	70		
71	-0.3295-01	-0.8406-01	-0.4896-01	-0.2305-U1	-0.1778-01	-0.4232-01	-0.2969-01	-0.8147-01	-0.4500-01	-0.2573-01	80		
81	-0.4911-01	-0.4570-01	-0.1979-01	-0.1519-01	-0.4238-01	-0.2311-01	-0.4703-U1	-0.3906-01	-0.2643-01	-0.7887-01	90		
91	-0.7786-01	-0.5816-01	-0.7303-01	-0.4712-U3	-0.3989-03	-0.9077-04	0.0000	0.0000	0.0000	0.0000	100		
SEGMENT	5	1	-0.9608-01	-0.6569-01	-0.1154-01	-0.6848-01	-0.6893-04	-0.5880-01	-0.9214-01	-0.7522-01	-0.7393-01	-0.9888-01	10
11	-0.7243-01	-0.2667-01	-0.9868-01	-0.6848-U1	-0.9318-02	-0.1254+00	-0.1074+00	-0.4273-01	-0.4712-03	-0.3989-03	-0.3989-03	20	
21	-0.9877-04	-0.9411-U1	-0.7045-01	-0.4273-U1	-0.4712-03	-0.3989-03	-0.9077-04	-0.8170-01	-0.5232-01	-0.1708-01	-0.1708-01	30	
31	-0.4712-03	-0.3989-03	-0.9077-04	-0.8370-01	-0.6399-01	-0.6389-01	-0.4712-05	-0.3989-03	-0.9077-04	-0.8954-01	-0.8954-01	40	
41	-0.5816-01	-0.1243-01	-0.4712-U3	-0.3989-03	-0.9077-04	-0.7786-01	-0.5816-01	-0.7303-01	-0.4712-03	-0.3989-03	-0.3989-03	50	
51	-0.9077-04	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	60	

## NORMAL FREQUENCY • 06167-04 CPS

SEGMENT	1	MODE NO.	2	3	4	5	6	7	8	9	10	11	
1	-0.2316-01	-0.2155-02	-0.5076-01	-0.1629-01	-0.6006-02	-0.1265+00	-0.3350-U1	-0.9001-03	-0.3535-01	-0.2774-01	-0.6632-02	20	
11	-0.6737-02	-0.3713-01	-0.2198-01	-0.1249-U1	-0.1096+00	-0.2781-01	-0.4708-02	-0.1894-01	-0.3915-01	-0.1894-01	-0.1894-01	30	
21	-0.5219-01	-0.2763-01	-0.1819-01	-0.9277-U1	-0.3451-01	-0.1351-01	-0.1695-01	-0.4480-01	-0.1228-01	-0.6904-01	-0.6904-01	40	
31	-0.3904-01	-0.1804-01	-0.3431-02	-0.3329-U1	-0.2380-01	-0.7591-01	-0.5045-01	-0.1793-01	-0.8584-01	-0.3894-01	-0.3894-01	50	
41	-0.2945-01	-0.5911-01	-0.4578-01	-0.2478-U1	-0.1660-01	-0.5610-01	-0.2354-01	-0.1024+00	-0.5035-01	-0.2934-01	-0.2934-01	60	
51	-0.3018-01	-0.4459-01	-0.3510-01	-0.4230-U1	-0.6176-01	-0.2924-01	-0.1195+00	-0.5075-01	-0.2548-01	-0.4065-01	-0.4065-01	70	
61	-0.5711-01	-0.3611-01	-0.5031-01	-0.6741-01	-0.3489-01	-0.1363+00	-0.6165-01	-0.4065-01	-0.6382-01	-0.5589-01	-0.5589-01	80	
71	-0.4640-01	-0.8685-02	-0.7306-01	-0.4054-01	-0.1532+00	-0.6154-01	-0.5206-01	-0.8142-02	-0.6841-01	-0.4741-01	-0.4741-01	90	
81	-0.8397-01	-0.7871-01	-0.4619-01	-0.1700+00	-0.7295-01	-0.5195-01	-0.9749-U1	-0.6720-01	-0.5771-01	-0.2498-01	-0.2498-01	90	
91	-0.1181-01	-0.1200-01	-0.7102-01	-0.7563-03	-0.1225-02	-0.1573-03	0.0000	0.0000	0.0000	0.0000	0.0000	100	
SEGMENT	2	1	-0.1408-01	-0.4639-01	-0.7836-03	-0.1873-U1	-0.3952-01	-0.2431-02	-0.1291-U1	-0.5673-01	-0.3977-01	-0.1866-01	10
11	-0.5097-01	-0.4521-U1	-0.2442-01	-0.7405-01	-0.7219-02	-0.5104-U1	-0.5104-U1	-0.3184-U1	-0.1856-U1	-0.6238-01	-0.6238-01	20	
21	-0.1109+00	-0.3007-U1	-0.5086-01	-0.1452+00	-0.2543-01	-0.5774-01	-0.1422+00	-0.2421-U1	-0.6803-01	-0.1821+00	-0.1821+00	30	
31	-0.2997-01	-0.6227-U1	-0.1933+00	-0.3572-U1	-0.5651-01	-0.2164+00	-0.2986-U1	-0.7368-01	-0.2533+00	-0.4138-01	-0.4138-01	40	
41	-0.6217-01	-0.2876+00	-0.3670-01	-0.6901-U1	-0.2841+00	-0.3551-U1	-0.7933-U1	-0.3244+00	-0.4127-01	-0.7357-01	-0.7357-01	50	
51	-0.3416+00	-0.4703-U1	-0.6782-01	-0.3587+00	-0.4116-01	-0.8498-01	-0.3956+00	-0.5268-01	-0.7347-01	-0.4299+00	-0.4299+00	60	
61	-0.4803-01	-0.8034-U1	-0.8034-01	-0.4682-U1	-0.9063-01	-0.4667+00	-0.5257-U1	-0.8488-U1	-0.4839+00	-0.5833-01	-0.5833-01	70	
71	-0.7912-01	-0.5010+00	-0.5247-U1	-0.9629-U1	-0.5379+00	-0.6398-01	-0.6477-U1	-0.5722+00	-0.7017-01	-0.9164-01	-0.9164-01	80	
81	-0.5691+00	-0.5812-01	-0.1U19+00	-0.6091+00	-0.6398-U1	-0.9618-01	-0.6262+00	-0.6963-U1	-0.9042-01	-0.6433+00	-0.6433+00	90	
91	-0.1181-U1	-0.3223-01	-0.8648-U1	-0.7563-03	-0.1225-02	-0.1573-U3	0.0000	0.0000	0.0000	0.0000	0.0000	100	
SEGMENT	3	1	-0.1966-01	-0.2157-U1	-0.3611-01	-0.2653-U1	-0.2622-01	-0.1119+00	-0.9323-U2	-0.2040-U1	-0.5003-01	-0.1508-01	10
11	-0.2616-01	-0.2247-U1	-0.2084-U1	-0.3191-U1	-0.9497-01	-0.1501-01	-0.1471-U1	-0.3310-U1	-0.3672-U2	-0.2605-01	-0.2605-01	20	
21	-0.6687-01	-0.1519-U1	-0.3756-01	-0.7813-U1	-0.8311-02	-0.3293-U1	-0.2297-U2	-0.1980-U2	-0.3170-01	-0.8373-01	-0.8373-01	30	
31	-0.3777-02	-0.3746-01	-0.1122-01	-0.9535-U2	-0.4322-01	-0.6130-U1	-0.7631-U2	-0.3735-U1	-0.1005+00	-0.3883-02	-0.3883-02	40	
41	-0.4887-01	-0.4447-U1	-0.2959-U2	-0.4419-U1	-0.3126-U1	-0.1326-U1	-0.4300-U1	-0.1137+00	-0.7526-U2	-0.4876-01	-0.4876-01	50	
51	-0.4485-01	-0.2764-U1	-0.5452-U1	-0.1768-U1	-0.1893-U1	-0.4866-U1	-0.1342+00	-0.7420-U2	-0.6017-U1	-0.1082-01	-0.1082-01	60	
61	-0.1429-01	-0.5553-01	-0.6498-U1	-0.2459-U1	-0.5431-01	-0.1510+00	-0.1883-U1	-0.6006-U1	-0.7849-01	-0.1307-01	-0.1307-01	70	
71	-0.6582-01	-0.6001-02	-0.3024-U1	-0.5996-U1	-0.1678+00	-0.1872-01	-0.7147-U1	-0.2283-U1	-0.2559-U1	-0.6683-01	-0.6683-01	80	
81	-0.9863-01	-0.3569-U1	-0.6561-01	-0.1A47+U0	-0.3013-01	-0.7137-U1	-0.1121+U0	-0.2437-U1	-0.7712-01	-0.3965-01	-0.3965-01	90	
91	-0.2193-01	-0.2212-U1	-0.5636-01	-0.7563-U3	-0.1225-02	-0.1573-U3	0.0000	0.0000	0.0000	0.0000	0.0000	100	

## MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

SEGMENT	5	MODE NO.	3	NORMAL FREQUENCY *	7804-04 CPS
1	-0.1672-01	-0.3359-01	-0.4013-01	-0.2840-01	-0.3843-01
1	-0.4527-01	-0.7407-01	-0.1186-01	-0.3843-01	-0.2081-01
21	-0.1573-03	-0.2014-01	-0.4185-01	-0.7726-02	-0.7563-03
31	-0.7563-03	-0.1225-02	-0.1573-03	-0.3223-01	-0.1225-02
41	-0.2212-01	-0.5636-01	-0.7563-03	-0.1573-03	-0.2212-01
51	-0.1573-03	-0.0000	-0.0000	-0.0000	-0.0000

SEGMENT	1	4507-01	2268-01	1263+00	4001-01	1701-02	1075+00	4635-01	7345-01	1136+00
1	-0.1188+00	-0.508-01	-0.1201+00	-0.3381-01	-0.2772-01	-0.1162+00	-0.1012+00	-0.5256-01	-0.4402-01	-0.1014+00
11	-0.4008-01	-0.1139+00	-0.2766-01	-0.5693-01	-0.1064+00	-0.3271-01	-0.8655-01	-0.9523-01	-0.3404-01	-0.1319+00
21	-0.1027+00	-0.2777-01	-0.1090+00	-0.1078+00	-0.2150-01	-0.8613-01	-0.8908-01	-0.2768-01	-0.1611+00	-0.1016+00
31	-0.1015+00	-0.1154+00	-0.9417-01	-0.2043-01	-0.1438+00	-0.8292-01	-0.2173-01	-0.1904+00	-0.8919-01	-0.1546-01
41	-0.1534-01	-0.9546-01	-0.1885-02	-0.1446+00	-0.7676-01	-0.1557-01	-0.2196+00	-0.8931-01	-0.3028-02	-0.1739+00
51	-0.1675+00	-0.8088-02	-0.2025+00	-0.7061-01	-0.9415-02	-0.2488+00	-0.7688-01	-0.3144-02	-0.2260+00	-0.8315-01
61	-0.8162-01	-0.2031+00	-0.6449-01	-0.3259-02	-0.2760+00	-0.7699-01	-0.9285-02	-0.2323+00	-0.6951-01	-0.4225-02
71	-0.3128-02	-0.2892-01	-0.2898-02	-0.3072+00	-0.6457-01	-0.9169-02	-0.2844+00	-0.7084-01	-0.1544-01	-0.2615+00
81	-0.2409+00	-0.4817-01	-0.8323-02	-0.9454-04	-0.7192-03	-0.1714-03	-0.0000	-0.0000	-0.0000	-0.0000
91	-0.1268+00	-0.7021-01	-0.8416-01	-0.9454-04	-0.7192-03	-0.1714-03	-0.0000	-0.0000	-0.0000	-0.0000

SEGMENT	2	7331-01	5714-01	1149+00	6584-01	3176-01	1212+00	8458-01	6872-01	1150+00
1	-0.1199+00	-0.3895-01	-0.1087+00	-0.7203-01	-0.9168-02	-0.1274+00	-0.7838-01	-0.9131-01	-0.1151+00	-0.9073-01
11	-0.7830-01	-0.4629-01	-0.1025+00	-0.7819-01	-0.1326-01	-0.1076+00	-0.8568-01	-0.1089+00	-0.2386-01	-0.30
21	-0.1026+00	-0.9026-01	-0.5912-02	-0.9637-01	-0.8435-01	-0.3569-01	-0.1028+00	-0.1030+00	-0.1462+00	-0.9021-01
31	-0.9050-01	-0.5812-01	-0.9530-01	-0.9796-01	-0.3265-01	-0.9660-01	-0.1092+00	-0.2101-01	-0.9033-01	-0.1029+00
41	-0.5078-01	-0.8406-01	-0.9666-01	-0.8055-01	-0.9044-01	-0.1154+00	-0.4346-01	-0.7790-01	-0.1028+00	-0.1030+00
51	-0.8296-01	-0.1103+00	-0.7764-01	-0.8429-01	-0.1215+00	-0.6590-01	-0.7801-01	-0.1152+00	-0.9567-01	-0.7174-01
61	-0.1090+00	-0.1254+00	-0.7613-01	-0.1277+00	-0.8633-01	-0.6559-01	-0.1151+00	-0.1479+00	-0.7065-01	-0.1226+00
71	-0.1225+00	-0.7197-01	-0.1338+00	-0.1108+00	-0.6570-01	-0.1276+00	-0.1405+00	-0.5943-01	-0.1213+00	-0.1703+00
81	-0.1268+00	-0.7021-01	-0.8416-01	-0.9454-04	-0.7192-03	-0.1714-03	-0.0000	-0.0000	-0.0000	-0.0000
91	-0.1158+00	-0.5919-01	-0.3184-01	-0.9454-04	-0.7192-03	-0.1714-03	-0.0000	-0.0000	-0.0000	-0.0000

SEGMENT	3	7092-01	3366-02	1151+00	7599-01	2522-01	1339+00	6964-01	4992-01	1276+00
1	-0.1226+00	-0.2707-01	-0.1213+00	-0.8219-01	-0.4219-02	-0.1277+00	-0.6345-01	-0.2050-01	-0.1400+00	-0.7580-01
11	-0.7591-01	-0.1275+00	-0.8834-01	-0.3343-01	-0.1350+00	-0.8329-01	-0.6206-01	-0.1462+00	-0.8196-01	-0.1083+00
21	-0.7913-01	-0.1399+00	-0.8823-01	-0.8549-01	-0.1337+00	-0.9450-01	-0.6265-01	-0.1523+00	-0.8811-01	-0.1398+00
31	-0.1007+00	-0.9188-01	-0.1473+00	-0.9557-01	-0.1203+00	-0.1647+00	-0.1004+00	-0.1961+00	-0.1521+00	-0.1130+00
41	-0.1440+00	-0.1068+00	-0.1211+00	-0.1708+00	-0.1066+00	-0.2253+00	-0.1645+00	-0.1129+00	-0.2024+00	-0.1503+00
51	-0.1546+00	-0.1079+00	-0.1796+00	-0.1770+00	-0.1127+00	-0.2545+00	-0.1644+00	-0.1253+00	-0.2088+00	-0.1719+00
61	-0.1191+00	-0.1831+00	-0.1189+00	-0.1831+00	-0.1769+00	-0.1769+00	-0.1252+00	-0.2669+00	-0.1706+00	-0.1314+00
71	-0.2374+00	-0.5919-01	-0.3184-01	-0.9454-04	-0.7192-03	-0.1714-03	-0.0000	-0.0000	-0.0000	-0.0000
81	-0.1158+00	-0.4747-01	-0.7101-01	-0.1509+00	-0.5494-01	-0.9640-01	-0.1445+00	-0.3620-01	-0.5942-01	-0.1508+00
91	-0.4247-01	-0.8920-01	-0.1571+00	-0.4874-01	-0.190+00	-0.1383+00	-0.4240-01	-0.3685-01	-0.1507+00	-0.3005-01

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MULTI-SEGMENT MODAL SYNTHESIS FOR ATM ARRAYS AND RACK

NORMAL FREQUENCY = 99674-04 CPS

SEGMENT 1		• 6117-03	• 9740-02	• 1258+00	• 8056-02	• 1562-01	• 1346+00	• 1367-01	• 8257-02	• 1009+00	• -6399-02
1		• 1563-01	• 1046+00	• 8721-03	• 2280+01	• 41083+00	• 6487-02	• 1073-02	• 1272+00	• 2081-01	• 1539-01
1		• 7479-01	• 6266+02	• 2994-01	• 8218-01	• 1495-01	• 2408-01	• 7332-01	• 2253-01	• 4866-01	• 30
2		• 2067-01	• 2980-01	• 5238-01	• 1340-01	• 3707-01	• 5605-01	• 3508-01	• 2967-01	• 2252-01	• 40
3		• 4421-01	• 2991-01	• 2918-01	• 3831-01	• 2120-01	• 4222-01	• 3681-01	• 3614-02	• 3495-01	• 50
4		• 7876-04	• 2768-01	• 5135-01	• 3771-02	• 4936-01	• 4395-01	• 2975-01	• 3482-01	• 5849-01	• 60
5		• 4349-01	• 5262-01	• 2120-01	• 5650-01	• 5108-01	• 5588-81	• 4923-01	• 5835-01	• 5219-01	• 4195-01
6		• 6563-01	• 4850-01	• 6364-01	• 5822-01	• 8202-01	• 4909-01	• 7276-01	• 7464-01	• 5777-01	• 70
7		• 8347-01	• 7077-01	• 6536-01	• 1082+00	• 6350-01	• 4045+00	• 7263-01	• 5623-01	• 6690-01	• 80
8		• 9864-02	• 3630-02	• 1573+00	• 3134-03	• 4142-03	• 1987-03	• 0000	• 0000	• 1008+00	• 90
9		• 91								• 1008+00	• 90
SEGMENT 2		• 3149-02	-• 2803-01	• 1084+00	-• 2726-02	-• 1937-01	• 1343+00	• 4632-02	-• 4109-01	• 8469-01	-• 2639-02
1		-• 3202-01	• 1113+00	-• 9910-02	-• 2655-01	• 1379+00	• 1182-01	-• 3391-01	-• 8105-01	-• 2505-02	-• 4823-01
1		• 8832-01	• 1075-01	-• 3369-01	• 1416+00	• 1119-01	-• 4237-01	• 1157+00	-• 6143-02	-• 5537-01	• 30
2		• 1691-01	• 4810-01	• 1186+00	-• 2419-01	• 4083-01	• 1452+00	-• 1676-01	-• 6251-01	• 9556-01	-• 3132-01
3		-• 4796-01	• 1488+00	-• 2542-01	-• 5660-01	• 1229+00	-• 2392-01	-• 6964-01	• 9919-01	-• 6237-01	• 50
4		• 1258+00	-• 3846-01	-• 5510-01	• 1524+00	• 3106-01	-• 7678-01	• 1028+00	-• 4560-01	-• 6224-01	• 60
5		-• 3973-01	-• 7092-01	• 1301+00	-• 8392-01	• 1064+00	-• 4547-01	-• 7665-01	• 1331+00	-• 5274-01	• 70
6		• 6938-01	• 1597+00	-• 4533-01	-• 9106-01	• 1101+00	-• 5987-01	-• 7651-01	• 1633+00	-• 5401-01	• 60
7		• 81	• 1374+00	-• 5247-01	-• 9820-01	• 1137+00	-• 5974-01	-• 9092-01	• 1403+00	-• 8365-01	• 90
8		• 91	• 9864-02	-• 2192-01	• 1040+00	• 3134-03	-• 4142-03	• 1987-03	• 0000	• 0000	• 100
SEGMENT 3		• 3803-02	-• 2023-01	• 1823+00	-• 4665-02	-• 2610-01	• 1735+00	• 1686-01	-• 1874-01	• 2072+00	• 9590-02
1		-• 2602-01	• 2035+00	• 2319-02	-• 3329-01	• 1998+00	• 9678-02	-• 1156-01	• 1809+00	• 2400-01	-• 2588-01
1		• 2333+00	• 9457-02	-• 4042-01	• 2259+00	• 1844-01	-• 3457-01	• 2348+00	• 3114-01	-• 3301-01	• 30
2		• 2387-01	-• 4029-01	• 2557+00	• 1659-01	-• 4756-01	• 2520+00	-• 3827-01	-• 4016-01	• 2856+00	• 2373-01
3		-• 5470-01	• 2782+00	-• 3237-01	-• 4880-01	• 2869+00	• 4541-01	-• 4730-01	• 3117+00	-• 3814-01	• 50
4		• 3040+00	-• 3087-01	-• 6184-01	• 3043+00	• 5255-01	-• 5454-01	• 3378+00	• 3698-01	-• 4698-01	• 60
5		• 61	• 4668-01	-• 6311-01	• 3393+00	• 5699-01	-• 6157-01	• 3640+00	• 5242-01	-• 6884-01	• 3603+00
6		• 71	-• 7611-01	• 3566+00	-• 6683-01	-• 6871-01	• 3901+00	-• 6228-01	• 3827+00	• 6096-01	• 70
7		• 81	• 3916+00	-• 7396-01	-• 7585-01	• 4162+00	-• 6669-01	-• 8312-01	• 4125+00	-• 5942-01	• 90
8		• 91	-• 2913-02	-• 9147-02	• 1508+00	• 3134-03	-• 4142-03	• 1987-03	• 0000	• 0000	• 100
SEGMENT 4		• 3312-01	• 1934-02	-• 3899-01	-• 6734-02	• 1061+00	• 8022-01	• 3163-01	• 1499-01	• 1298+00	• 3890-01
1		• 7722-02	• 1032+00	• 4618-01	• 4504-03	• 7657-01	• 2445-01	• 1809-02	• 1335+00	• 2213-01	• 30
1		• 1262+00	• 5331-01	• 7588-02	• 7295-01	• 4745-01	• 1627-01	• 9886-01	• 4591-01	• 1226+00	• 30
2		• 5218-01	• 2200+00	• 9595-01	• 6404-01	• 1471-01	• 1473-01	• 6932-01	• 3641-01	• 1190+00	• 4675-01
3		• 5218-01	• 2200+00	• 9595-01	• 6404-01	• 1471-01	• 1473-01	• 6932-01	• 3641-01	• 1190+00	• 4675-01

**APPENDIX B**

**LISTING OF MODAL SYNTHESIS PROGRAM**

COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

3 FOR IS MAIN,MAIN  
CYCLE 000 COMPILED BY 1201 BC57E ON 13 JUL 70 AT 13:18:52.

MAIN PROGRAM

STORAGE USES: CODE(1) 0000041: DATA(0) 0000321 BLANK COMMON(2) 0000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 INPUT  
0004 SYNTH  
0005 MODES  
0006 SHAPES  
0007 NINTR\$  
0010 NSTOPS\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000 I 000025 NC 0000 I 000022 NCASE 0000 I 000000 ND 0000 I 000011 NMQ  
0000 I 000024 NV

00100 1\* C  
00100 2\* C  
00100 3\* C  
00100 4\* C  
00101 5\* C  
00103 6\* C  
00104 7\* C  
00105 8\* C  
00106 9\* C  
00107 10\* C

MULTI-SEGMENT MODAL SYNTHESIS PROGRAM  
S. V. HOJ MAY, 1970

DIMENSION ND(9), NMQ(9)  
CALL INPUT(NCASE, NTS, ND, NMQ, NV)  
CALL SYNTH(NTS, ND, NMQ, NC)  
CALL MODES(NCASE, NC, NV, 31, 1, 32, 1)  
CALL SHAPES(NTS, ND, NMQ, NC, NV)  
END

END OF COMPILATION: NO DIAGNOSTICS.

3 FOR,IS INPT,INPT  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:19:21.

SUBROUTINE INPT ENTRY POINT 000704

STORAGE USED: CODE(1) 0007461 DATA(0) 0025751 BLANK COMMON(2) 054266

EXTERNAL REFERENCES (BLOCK, NAME)

0003	EXIT
0004	NRNL\$
0005	NWDUS
0006	VID2\$
0007	N101\$
0010	NRBUS
0011	NREWS
0012	NMBJS
0013	NERRJS\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000657	100L	0001	000320	1000L	0000	002314	101F	0000	002322	102F	0000	002330	103F					
0000	002340	104F	0000	002350	105F	0000	002355	106F	0000	002404	107F	0000	002423	108F					
0000	002435	109F	0000	002451	110F	0000	002457	111F	0000	002500	112F	0000	002514	113F					
0000	002443	114F	0001	000252	12L	0001	00036	130G	0001	00060	1436	0001	000163	1776					
0001	00176	206G	0001	000222	2226	0001	000457	23L	0001	000262	2476	0001	000357	2736					
0001	000240	3L	0001	000542	30L	0001	000357	306G	0001	000404	316G	0001	000515	3706					
0001	000422	327G	0001	000450	350G	0001	000502	360G	0001	000503	3626	0001	000611	4246					
0001	000533	377G	0001	000600	40L	0001	000554	406G	0001	000572	4156	0001	000223	DUMMY					
0001	000636	433G	0001	000330	5L	0001	000366	BL	0002	R	000322	A	0000	R	0002531	INJPS			
0000	R	001760	FQ	0000	R	002226	GK	0000	I	002207	I	0000	I	002213	I	0000	I	002227	J
0000	I	002222	I REC	0000	I	002221	ITAPE	0000	I	002225	UNIT	0000	I	002224	J	0000	I	002220	NDI
0000	I	002224	K	0000	I	002210	NCT	0000	I	002215	NCT2	0000	I	002216	NCT2	0000	I	000000	NWP
0000	I	002230	NE	0000	I	002235	NLTBL1	0000	I	002212	NME	0000	I	000011	NML	0000	I	000143	NRECRB
0000	I	002217	NMP1	0002	I	000001	NR	0002	I	000012	NRD	0000	I	000132	NREC	0000	I	002206	NTD
0002	I	000022	NRG	0000	I	002211	NRGI	0000	I	000033	NRGSQ	0000	I	000121	NTAPE	0000	I	000121	NTAPE
0002	I	000000	NTR	0000	R	000154	RIG	0000	R	000154	RIG	0000	R	000154	RIG	0000	I	000121	NTAPE

```

00101 1*      C          SUBROUTINE INPT(NCASE,NTS,NJ,NMQ,NV)
00101 2*      C          DIMENSION NJ(9),NMP(9),NMQ(9),NML(9),NRL(9),NRD(2,100)
00103 3*      C          DIMENSION NRG(9),NRGSQ(6,9),NTAPE(9),NREC(9),NRECRB(9)
00104 4*      C          DIMENSION NTB(150,150),RIG(150,6),FQ(150)
00105 5*      C          COMMON NTR,NR,NRD,A
00106 6*      C          NAMELIST/INPUT/NJ,NMP,NML,NTR,NR,NRD,NRG,NRGSQ,NTAPE,NREC,
00107 7*      C          /NRECRB,NCASE,NTS,NV
00107 8*      C          READ(5,INPUT)
00110 9*      C          READ(5,INPUT)
00110 10*     C          LIST INPUT DATA
00110 11*     C
00110 12*     C

```

## COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

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00110      13*      C      WRITE(6,101)
00113      14*      C      WRITE(6,101,'45X,'MODAL SYNTHESIS')
00115      15*      101     FORMAT('1','45X,'MODAL SYNTHESIS')
00116      16*      WRITE(6,102)NTS
00121      17*      102     FORMAT('//5X,'NO. OF SEGMENTS = ',I2)
00122      18*      WRITE(6,103)NTR
00125      19*      103     FORMAT('/5X,'NO. OF INTERFACE RESTRAINTS = ',I3)
00125      20*      C      NTD=0
00126      21*      DO 1 I=1,NTS
00127      22*      1       NTENDD+ND(I)
00132      23*      NTENDD-NTR
00134      24*      WRITE(6,104)NTD
00135      25*      FORMAT(/5X,'NO. OF DOF OF OVERALL SYSTEM = ',I4)
00140      26*      C      NCT=0
00140      27*      28*      DO 3 I=1,NTS
00142      29*      NRGIERG(I)
00145      30*      WRITE(6,105)I
00146      31*      32*      FORMAT('/5X,'FOR SEGMENT NO. ',I2)
00151      33*      WRITE(6,106)ND(I),NMQ(I)
00152      34*      35*      FORMAT('/10X,'NO. OF DOF = ',I3//10X,'NO. OF MODES AVAILABLE = ',I3
00157      36*      ,/10X,'NO. OF MODES USED IN SYNTHESIS = ',I3,10X,'WHICH INCLUDES'
00160      37*      NME=NMQ(I)-NRG(I)
00161      38*      WRITE(6,107)NRG(I),NME,NML(I)
00166      39*      40*      FORMAT(/15X,I2,' RIGID BODY MODES'/14X,I3,' ELASTIC MODES
00166      39*      /STA
00167      40*      WRITE(6,108)NR(I)
00172      41*      42*      FORMAT(/10X,'NO. OF RESTRAINTS TO ADJACENT SEGMENTS = ',I2)
00173      42*      II=NCT+1
00174      43*      NCT=NCT+NR(I)
00175      44*      WRITE(6,109)(NRD(I,J),J=II,NCT)
00203      45*      46*      FORMAT(/15X,'RESTRAINT NO. ',(25I4))
00204      46*      WRITE(6,114)(NRD(12,J),J=II,NCT)
00212      47*      48*      FORMAT(15X,'DOF NO. ',(25I4))
00213      49*      50*      WRITE(6,110)
00215      51*      52*      FORMAT(/10X,'STORAGE OF SEGMENT MODES')
00216      51*      WRITE(6,111)NTAPE(I),NREC(I),(NR65Q(J,I),J=1,NRI)
00226      52*      53*      FORMAT(/15X,'TAPE UNIT NO. = ',I3//15X,'RECORD POSITION NO. = ',I3/
00227      53*      ,15X,'RIGID BODY MODE NOS. = ',6I4)
00232      54*      55*      IF(NREC(I),3,2
00232      54*      2       WRITE(6,112)NREC(I)
00235      55*      56*      57*      58*      59*      60*      FORMAT(15X,'ADDITIONAL RECORD POSITION NO. FOR RIGID BODY MODES =
00235      56*      57*      58*      59*      60*      61*      62*      63*      64*      65*      66*      67*      68*      69*
00236      57*      C      CONTINUE
00236      58*      C      CONSISTENCY CHECK
00236      59*      C
00236      60*      C      IF('V=60')12,12,11
00240      61*      11     NV=60
00243      62*      11     NV=60
00244      63*      12     NCT1=0
00244      63*      NCT2=0
00245      64*      NCT2=0
00245      64*      DO 4 I=1,NTS
00246      65*      NCT1=NCT1+NMQ(I)
00251      66*      NCT2=NCT2+NR(I)
00252      67*      IF(NMQ(I) .GT. NMP(I)) GO TO 1000
00253      68*      IF(NMP(I) .GT. ND(I)) GO TO 1000
00255      69*      4       IF(NMP(I) .GT. ND(I)) GO TO 1000

```

## COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

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00260    70*      IF(NCT1 .GT. 150) GO TO 1000
00262    71*      IF(NCT2 .GT. 100) GO TO 1000
00264    72*      GO TO 5
00265    73*      1000  WRITE(6,113)
00266    74*      113  FORMAT('//10X,*WRONG INPUT -- STOP*')
00267    75*      CALL EXIT
00268    76*      GO TO 100
00271    77*      C
00271    78*      C      CONVEY SEGMENT MODES FROM TAPE TO TEMPORARY STORAGE FILES
00271    79*      C
00272    80*      C      DO 45 I=1,NTS
00272    81*      C      READ IN FULL SET MODES FROM TAPE TO IN-CORE
00272    82*      C
00272    83*      C
00275    84*      NMPI=NMP(I)
00276    85*      NDI=ND(I)
00277    86*      NRGI=NRG(I)
00278    87*      ITAPE=NTAPE(I)
00300    88*      IREC=NREC(I)-1
00301    89*      IF(IREC)1000,9,6
00302    90*      6      DO 7 JE1,IREC
00305    91*      7      READ(ITAPE)DUMMY
00310    92*      8      READ(ITAPE)((A(K,J),J=1,NMPI),K=1,NDI)
00314    93*      9      READ(ITAPE)(FQ(J),J=1,NMPI)
00325    94*      C      PICK UP RIGID BODY MODES
00325    95*      C
00333    96*      C      IUNIT=20+I
00333    97*      C      REWIND IUNIT
00334    98*      C      IF(NRG(I))1000,40,10
00335    99*      C      10     IF(NRECRB(I))1000,30,20
00340   100*      C      FOR SPECIALLY COMPUTED RIGID BODY MODES IN SEPARATE RECORD
00340   101*      C
00340   102*      C
00340   103*      C      20     IREC=NRECRB(I)-1
00344   104*      C      IF(IREC)1000,23,21
00347   105*      C      21     DO 22 J=1,IREC
00352   106*      C      22     READ(ITAPE)DUMMY
00356   107*      C      23     READ(ITAPE)((RIG(J,K),K=1,NRGI),J=1,NDI)
00367   108*      C      24     DO 24 JE1,NRGI
00372   109*      C      K=NRG5Q(J,I)
00373   110*      C      25     6K=0.
00374   111*      C      24     WRITE(IUNIT)GK,(RIG(JJ,K),JJ=1,NDI)
00404   112*      C      25     GO TO 40
00404   113*      C
00404   114*      C      FOR RIGID BODY MODES IN THE SAME RECORD WITH ELASTIC
00404   115*      C
00405   116*      C      30     DO 31 J=1,NRGI
00410   117*      C      K=NRG5Q(J,I)
00411   118*      C      31     6K=0.
00412   119*      C      WRITE(IUNIT)GK,(A(JJ,K),JJ=1,NDI)
00412   120*      C
00412   121*      C      31     WRITE(IUNIT)GK,(A(JJ,K),JJ=1,NDI)
00412   122*      C      PICK UP ELASTIC MODES
00412   123*      C
00422   124*      C      40     NE=NMQ(I)-NRG(I)
00423   125*      C      DO 41 J=1,NE
00426   126*      C      K=NML(I)+J-1

```

## COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

```
00427    127*      GK=(FQ((J)*6.2832)**2
00430    128*      41   WRITE(IJUNIT)GK,(A(JJ,K),JJ=1,NDI)
00430    129*      C
00440    130*      REWIND IUNIT
00441    131*      45   CONTINUE
00443    132*      REWIND ITAPE
00443    133*      C
00444    134*      100  RETURN
00444    135*      END
00445
```

END OF COMPILED:

NO DIAGNOSTICS.

FOR IS SYNT<sub>1</sub> SYNT<sub>2</sub>  
 CYCLE 000 COMPILED BY 1201 ECSTE ON 13 JUL 70 AT 13:19:40.

SUBROUTINE SYNTH ENTRY POINT 000561

STORAGE USED: CODE(1) 000622; DATA(0) 020111; BLANK COMMON(2) 054266

EXTERNAL REFERENCES (BLOCK, NAME)

0003	EXIT
0004	DSPACE
0005	DJPT
0006	VRBJ\$
0007	VI01\$
0010	VI02\$
0011	VRENS\$
0012	VRDJS\$
0013	VRBJS\$
0014	NERJS\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000534	100L	0001	000173	1000L	0000	017761	101F	0000	017771	102F	0n00	020000	105F
0000	020003	106F	0000	020011	107F	0000	020017	108F	0001	000013	113G	0001	000022	120G
0001	000047	126G	0001	000063	135G	0001	000100	144G	0001	000133	160G	0001	000164	173G
0001	000243	217G	0001	000247	223G	0001	000315	234G	0001	000336	247G	0001	000341	252G
0001	000346	257G	0001	000404	274G	0001	000203	30L	0001	000415	302S	0001	000435	314G
0001	000441	320G	0001	000505	334G	0001	000511	340G	0001	000122	4L	0001	000124	7L
0002	R 000322	A	0000	R 017500	AK	0000	R 017252	AW	0000	R 000226	3Y	0000	D 017726	DA
0000	D 017730	D3	0000	D 017732	DC	0000	D 017736	DK	0000	D 017734	DW	0000	R 000000	FQ
0000	I 017743	I	0000	I 017750	IC	0000	I 017740	IC0L	0000	I 017742	IFQ	0000	020045	INJP\$
0000	I 017752	I2	0000	I 017744	ISEG	0000	I 017751	UNIT	0000	I 017756	J	0000	I 017757	JJ
0000	I 017760	K	0000	I 017024	LA	0000	I 017753	NBY	0000	I 017741	NCT	0000	I 017754	NCG
0000	I 017745	NCI	0000	I 017746	NWQI	0002	I 000001	NR	0000	I 016742	VRCK	0002	I 000012	VRD
0000	I 017747	NRI	0002	I 000000	NTR	0000	R 017755	SIGW						

```

SUBROUTINE SYNT(HNTS,ND,NM0,NC)
DIMENSION NJ(9),VQ(9),VR(9),VRD(2,100),A(150,150)
DIMENSION FQ(150),BQY(50,150),VRCK(50),LA(150),AM(150),AK(150)
DOUBLE PRECISION DA,D3,C,CW,CK
COMMON VTR,VR,VRD,A
C
SET JP COMPATIBILITY MATRIX
 1*      C
 2*      C
 3*      C
 4*      C
 5*      C
 6*      C
 00106 7*      C
 00106 8*      C
 00107 9*      C
 00110 10*     C
 00111 11*     C
 00112 12*     C
 00115 13*     C
 00115 14*     C
  
```

## COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

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```

00117 15*      DO 10 ISEG=1,NTS
00117 16*      C
00122 17*      ND1=ND((ISEG))
00123 18*      NMQI=NMQ((ISEG))
00124 19*      NRIENR((ISEG))
00125 20*      DJ 2 IC=1,NMQI
00130 21*      IJNIT=20+ISEG
00131 22*      IFQ=IFQ+1
00132 23*      2 READ(IJNIT)F@((IFQ),(A(I,IC),I=1,NCT)
00142 24*      REWIND IJNIT
00142 25*      C
00143 26*      DO 6 IRI=1,NRI
00146 27*      NCT=NCT+1
00147 28*      NBY=NRD(1,NCT)
00150 29*      NDG=NRD(2,NCT)
00151 30*      IF (NRCK(NBY))1000,3,4
00154 31*      3 SIGM=1,
00155 32*      GO TO 7
00156 33*      SIGM=-1.
00157 34*      DO 5 JE=1,NMQI
00162 35*      JJ=ICOL+J
00163 36*      BDY(NBY,JJ)=ADG(J)*SIGM
00163 37*      C
00165 38*      NRCK(NBY)=NRCK(NBY)+1
00167 39*      ICOL=ICOL+NMQ((ISEG))
00167 40*      C
00170 41*      10 CONTINUE
00170 42*      C
00170 43*      C
00170 44*      C
00172 45*      DO 20 I=1,NTR
00175 46*      IF (NRCK(I)-2)1000,20,1000
00200 47*      20 CONTINUE
00202 48*      GO TO 30
00203 49*      1000 WRITE(6,101)
00205 50*      101 FORMAT(//30X,'RESTRAINTS ARE NOT IN PAIR -- STOP')
00206 51*      CALL EXIT
00207 52*      GO TO 100
00207 53*      C
00207 54*      C
00207 55*      C
00210 56*      30 CALL DSPACE (50,150,NTR,ICOL,BDY,A,LA)
00210 57*      C
00211 58*      102 FORMAT(//T30,'TRANSFORMATION MATRIX'//)
00213 59*      NCEICOL=NTR
00214 60*      REWIND 34
00215 61*      WRITE(6,102)
00216 62*      DO 31 I=1,ICOL
00221 63*      31 WRITE(34)(A(I,K),K=1,NC)
00230 64*      REWIND 34
00231 65*      CALL OJPT(A,150,150,ICOL,NC,1)
00232 66*      WRITE(6,105)(LA(I),I=1,ICOL)
00240 67*      105 FORMAT(//1H ,(20(I5)))
00240 68*      C
00240 69*      C
00240 70*      C
00241 71*      C
REWIND 31

```

## COPY MULTI-SEG MODAL SYNTH PROGRAM IN TAPE

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```

00242    72*      REWIND 32
          73*      WRITE(6,106)
00243    74*      106  FORMAT('//T30,'PSUEJO MASS MATRIX'//')
00245    75*      DO 42 I=1,NC
00246    76*      DO 41 J=1,NC
00251    77*      DM=0
00254    78*      DK=0
00255    79*      DO 40 K=1,ICOL
00256    80*      DA=A(K,I)
00261    81*      DB=A(K,J)
00262    82*      DCFQ(K)
00263    83*      40  DC=AC+MC*DC
00264    84*      40  DK=DC*DB*DC
00265    85*      AW(J)=K
00267    86*      41  AK(J)=K
00270    87*      WRITE(31)(AM(J),J=1,NC)
00272    88*      42  WRITE(32)(AK(J),J=1,NC)
00300    89*      C
00307    90*      REWIND 31
00310    91*      WRITE(6,107)
00312    92*      107  FORMAT('//T30,'PSUEJO MASS MATRIX'//')
00313    93*      DO 43 I=1,NC
00316    94*      43  READ(31)(A(I,K),K=1,NC)
00325    95*      CALL QUPT(A,150,150,NC,NC,1)
00326    96*      REWIND 31
00326    97*      C
00327    98*      REWIND 32
00330    99*      WRITE(6,108)
00332   100*      108  FORMAT('//T30,'PSUEJO STIFFNESS MATRIX'//')
00333   101*      DO 44 I=1,NC
00336   102*      44  READ(32)(A(I,K),K=1,NC)
00345   103*      CALL QUPT(A,150,150,NC,NC,1)
00346   104*      REWIND 32
00347   105*      100 RETURN
00350   106*      END

```

END OF COMPILE: NO DIAGNOSTICS.

3 FOR,IS, OJPT,OJPT  
 CYCLE 000 COMPILED BY 1201 3C5TE ON 13 JUL 70 AT 13:20:07.

SUBROUTINE OJPT ENTRY POINT 000215

STORAGE USED: CODE(1) 000234; DATA(0) 000054; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	NWDJS
0004	NI01\$
0005	NI02\$
0006	NERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000106	10L	0001	000200	100L	0000	000007	101F	0000	000013	102F
0001	000025	1116	0001	000042	1226	0001	000066	1276	0001	000122	1476
0001	000161	1656	0000	000005	ICOL	0000	000025	INJP\$	0000	000001	IROW
0000	1	000003	12	0000	1	000004	J	0000	1	000005	K

```

00101   1*      SUBROUTINE OJPT(A,NRX,NCX,NR,NC,IP)
00103   2*      DIMENSION A(NRX,NCX)
00103   3*      C          PRINT BY ROW IF IP=1
00103   4*      C
00103   5*      C
00104   6*      C          IF(IP=1)10,1,10
00107   7*      1          LC=(NC+9)/10
00110   8*      DO 2 IROW=1,NR
00113   9*      I1=1
00114  10*      I2=10
00115  11*      WRITE(6,101)IROW
00120  12*      101 FORMAT(//T15,ROW *,I3)
00121  13*      DO 2 J=1,LC
00124  14*      WRITE(6,102)I1,(A(IROW,K),K=I1,I2),I2
00134  15*      102 FORMAT(2X,I5,3X,10(E11.4),I6)
00135  16*      I1=I1+10
00136  17*      2          I2=I2+10
00141  18*      GO TO 100
00141  19*      C          PRINT BY COLUMN IF IP=2
00141  20*      C
00141  21*      C          IF(IP=2)100,11,100
00142  22*      10         LC=(NR+9)/10
00145  23*      11         DO 12 ICOL=1,NC
00146  24*      12         I1=1
00151  25*      26*         I2=10
00152  27*      WRITE(6,103)ICOL
00153  28*      103        FORMAT(//T15,COLJVN *,I3)
00156  29*      DO 12 J=1,LC

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```
00162 30*      WRITE(6,102)I1,(A(K,ICOL),K=I1,I2),I2
00172 31*      I1=I1+10
00173 32*      12 I2=I2+10
00176 33*      100 RETURN
00177 34*      END
```

END OF COMPIILATION: NO DIAGNOSTICS.

3 CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:20:33.

SUBROUTINE DSPACE ENTRY POINT 000602

STORAGE USED: CODE(1) 0006441 DATA(0) 000110; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	VNDJS
0004	VI02S
0005	VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000551	1000L	0001	000053	1073	0001	000365	11L	0001	000054	1126
0001	000065	1206	0001	000077	125G	0001	000143	134G	0001	000146	137G
0001	000241	1716	0001	000164	2L	0001	000315	211G	0001	000341	222G
0001	000374	237G	0001	000437	243G	0001	000446	247G	0001	000472	260G
0001	000527	273G	0000	000023	4300F	0001	000556	900L	0000	000011	A3
0000	R 000012	CJ	0000	R 000017	EF	0000	R 000000	EPS	0000	R 000016	F6
0000	I 000031	INJP\$	0000	I 000022	II	0000	I 000003	J	0000	I 000007	JA
0000	I 000010	K	0000	I 000013	LJ	0000	I 000014	LNC	0000	I 000005	NC
0000	I 000004	NR	0000	I 000001	N1	0000	R 000015	ZA	0000	I 000021	NE

```

00101 1*
00103 2*
00104 3*
00105 4*
00106 5*
00111 6*
00114 7*
00117 8*
00122 9*
00124 10*
00127 11*
00130 12*
00131 13*
00132 14*
00133 15*
00136 16*
00141 17*
00142 18*
00143 19*
00146 20*
00147 21*
00150 22*
00151 23*
00154 24*
00157 25*
      NRE=J
      NCE=J
      EC=A35(A(J,J))
      JA=J+1
      DO 2 K=J,N
      DO 2 I=J,L
      AB=A35(A(K,I))
      CJ=BC-AB
      IF(CJ)3,2,2
      3  BC=A3
      VR=K
      NC=I
      2  CONTINUE
      DO 4 I=1,N
      4  AB=A(I,J)

```

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```

00160      26*      C:=A(I,NC)
00161      27*      A(I,J)=C
00162      28*      A(I,NC)=AB
00163      29*      LJ=LA(NC)
00164      30*      LNC=LA(J)
00165      31*      LA(J)=LJ
00166      32*      LA(NC)=LNC
00170      33*      DO 5 I=J,L
00173      34*      A3=A(J,I)
00174      35*      C:=A(NR,I)
00175      36*      A(J,I)=CD
00176      37*      A(NR,I)=AB
00200      38*      IF (J-1)1000,12,13
00203      39*      ZA=ABS(A(J,J))
00204      40*      IF (ZA.LE.EPS) GO TO 1000
00206      41*      CONTINUE
00207      42*      FG=A(J,J)
00210      43*      DO 6 I=J,L
00213      44*      A(J,I)=A(J,I)/FG
00215      45*      IF (N-J)1000,11,7
00220      46*      CONTINUE
00221      47*      DO 10 I=JA,N
00224      48*      EF=A(I,J)
00225      49*      DO 10 K=J,L
00230      50*      A(I,K)=A(I,K)
00233      51*      -EF*A(J,K)
00235      52*      CONTINUE
00235      53*      CONTINUE
00235      54*      C START BACK SUBSTITUTION
00235      55*      C
00236      56*      DO 100 J=1,N1
00241      57*      J1=J+1
00242      58*      DO 101 I=1,J
00245      59*      FG=A(I,J1)
00246      60*      DO 101 K=J,L
00251      61*      A(I,K)=A(I,K)-FG*A(J1,K)
00254      62*      CONTINUE
00256      63*      NEL=N
00256      64*      C COMPUTE TRANSFORMATION MATRIX
00257      65*      DO 50 I=1,N
00262      66*      I1=LA(I)
00263      67*      DO 50 J=1,NE
00266      68*      J1=N+J
00267      69*      X(I1,J)=A(I,J1)
00272      70*      DO 51 J=1,NE
00275      71*      K=N+J
00276      72*      I1=LA(K)
00277      73*      X(I1,J)=1.0
00301      74*      DO 100 CONTINUE
00302      75*      1000 WRITE(6,4300)
00303      76*      FORMAT(1H,4-IJER)
00305      77*      4300 FORMAT(1H,4-IJER)
00306      78*      900 CONTINUE
00307      79*      RETURN
00310      80*      END

```

END OF COMPILE: NO DIAGNOSTICS.

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FOR IS MODES, MODES  
CYCLE 000 COMPILED BY 1201 BC57E ON 13 JUL 70 AT 13:21:04.

SUBROUTINE MODES ENTRY POINT 0000036

STORAGE JSED: CODE(1) 000062; DATA(0) 010214; BLANK COMMON(2) 0000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 STEP1  
0004 STEP2  
0005 STEP3  
0006 VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000 R 000000 EIS 0000 010207 INUPS 0000 I 010206 LV 0000 R 0000036 W

00101 1\* SUBROUTINE MODES(NCASE,N,V,V,ITM,IRM,ITK,IRK)  
00103 2\* PARAMETER NX=140, VVX=30  
00104 3\* DIMENSION EIG(NVX), W(NX,VVX)  
00105 4\* CALL STEP1(NCASE,N,V,V,ITM,IRM,ITK,IRK)  
00106 5\* CALL STEP2(N,V,EIG,W,LV)  
00107 6\* CALL STEP3(N,V,EIG,W,LV)  
00110 7\* RETURN  
00111 8\* END

END OF COMPILATION: NO DIAGNOSTICS.

3 FOR,IS STEP1,STEP1  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:21:43.

SUBROUTINE STEP1 ENTRY POINT 000306

STORAGE JSEG: CODE(1) 000346; DATA(0) 024141; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	MAP
0004	VREWS
0005	VRJS
0006	VICIS
0007	VIOS
0010	VWBS
0011	VWDJS
0012	VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000266	100L	0001	000261	100L	0000	024070	101F	0001	000013	115G
0001	000161	13L	0001	000040	130G	0001	000047	135G	0001	000105	155G
0001	000152	200G	0001	000165	207G	0001	000172	213G	0001	000203	221G
0001	000022	3L	0001	000061	5L	0001	000111	6L	0000	R 023646	JUM
0000	I 024064	I	0000	I 023624	IAB	0000	I 024110	INUP\$	0000	I 024066	J
0000	I 024062	LL	0000	I 024063	VREC	0000	R 023630	OP	0000	R 023642	OPCH
0000	R 000000	S	0000	R 023216	TITLE				0000	R 023636	OT

```

00101 1* SUBROUTINE STEP1(NCASE,N,V,ITW,IRW,ITK,IRK)
00103 2* PARAMETER NX=140, NVX=30, NX=NX*(NX+1)/2
00104 3* DIMENSION S(NVX)
00105 4* DIMENSION TITLE(262), IA3(4), OP(6), OT(4), OPCH(4), JUM(NX)
00105 5* C CONVEY V FROM TAPE TO WORKING FILE
00105 6* C
00105 7* C
00106 8* REWIND 33
00107 9* LL=0
00110 10* NREC=IRW-1
00111 11* IF(NREC)5,3,1
00114 12* 1 DO 2 I=1,NREC
00117 13* 2 READ(ITW)JUM
00123 14* 3 DO 4 I=1,N
00126 15* 3 READ(ITW)(JUM(J),J=1,N)
00134 16* 4 DO 4 J=1,N
00137 17* LL=LL+1
00140 18* 4 S(LL)=JUM(J)
00143 19* 4 GO TO 5
00144 20* 5 READ(ITW)NCASE,N
00150 21* LL=N*(N+1)/2
00151 22* READ(ITW)(S(I),I=1,LL)

```

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00157 23*      6      WRITE(33)NCASE,N
00163 24*      WRITE(33)(S(I),I=1,LL)
00163 25*      C
00163 26*      C      CONVEY K FROM TAPE TO WORKING FILE
00163 27*      C
00171 28*      NREC=IRK-1
00172 29*      IF(NREC>1000,13,11
00175 30*      11      REWIND ITM
00176 31*      REWIND ITK
00177 32*      DO 12 I=1,NREC
00202 33*      READ(ITK)DUMMY
00206 34*      DO 14 I=1,N
00211 35*      READ(ITK)(DUM(J),J=1,N)
00217 36*      WRITE(33)(DUM(J),J=1,N)
00226 37*      REWIND ITK
00227 38*      REWIND 33
00227 39*      MODAL ANALYSIS BY MAP
00230 40*      DO 21 I=1,262
00233 41*      TITLE(I)=' '
00235 42*      IA3(1)=33
00236 43*      IA3(2)=33
00237 44*      IA3(3)=2
00240 45*      IA3(4)=2
00241 46*      OP(1)=2
00242 47*      OP(2)=2
00243 48*      OP(3)=3
00244 49*      OT(1)=0
00245 50*      OPCH(1)=0
00246 51*      CALL MAP(S,NX,TITLE,1,1,NV,0,IAB,0,OP,OT,OPCH,L,$1000)
00247 52*      GO TO 100
00250 53*      1000 WRITE(6,101)
00252 54*      101 FORMAT(T10,'MODAL ANALYSIS DELETED')
00253 55*      100 RETURN
00254 56*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

3 FOR,IS STEP2,STEP2  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:22:05.

SUBROUTINE STEP2 ENTRY POINT 000272

STORAGE USED: COJE(1) 000331; DATA(0) 037724; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

```

0003  VECTOR
0004  NREMS
0005  NRBS
0006  NI01S
0007  NI02S
0010  NMDS
0011  SORT
0012  NMBS
0013  NERRS

```

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

```

0000  037660 102F    0000  037666 103F    0001  000014 1136    0001  000025 1176    0001  000034 124G
0001  000070 141G    0001  000075 145G    0001  000103 152G    0001  000150 164G    0001  000172 174G
0001  000201 201G    0001  000235 216G    0001  000054 22L    0001  000251 226G    0001  000056 23L
0001  000211 51L    0001  000222 60L    0000  R 033366 3     0000  R 036776 2     0000  R 037224 D
0000  R 037440 FR3   0000  I 037655 1     0000  037704 INJP3   0000  I 037654 15    0000  I 037657 J
0000  I 037656 K    0000  R 000000 S     0000  R 037034 SD    0000  R 023216 V     0000  R 037072 W1
0000  R 037130 W2   0000  R 037166 W3   0000  R 035172 Z

```

```

00101  1*          SUBROUTINE STEP2(V,EIG,W,LV)
00103  2*          PARAMETER NX=140, NVX=30, NVX=N*(NX+1)/2
00104  3*          DIMENSION S(NNX),V(NX,NVX),W(NX,NVX),EIG(NVX)
00105  4*          DIMENSION B(NVX,NVX),Z(NVX,NVX),J(NVX),S(J(NVX))
00106  5*          DIMENSION W1(NVX), W2(NVX), W3(NVX), DM(NX),FR3(140)
00106  6*          C
00106  7*          C
00106  8*          C
00107  9*          C
00110 10*          C
00110 11*          C
00111 12*          C
00112 13*          C
00115 14*          C
00123 15*          C
00126 16*          C
00127 17*          C
00127 18*          C
00132 19*          C
00135 20*          C
00136 21*          C

```

```

          IMPROVED BY RAYLEIGH QUOTIENT
          REMIND 17
          REWIND 18      ---- SET MATRIX A ----
          IS=0
          DO 31 I=1,N
          READ(17)(DM(I,J),J=1,N)
          DO 31 J=1,N
          IS=IS+1
          S(IS)=DM(J)
          31

```

```

          IF (NV-20)21,21,22
          21  LV=NV
          21  GO TO 23

```

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00137   22*    22      LV=20
00140   23*    23      DO 32 I=1,LV
00143   24*    READ(18)(DM(<),K=1,N)
00151   25*    32      DO 32 J=1,N
00154   26*    32      V(J,I)=DM(J)
00154   27*    C       GET IMPROVED LV MODES
00154   28*    C
00157   29*    C
00157   30*    CALL VECTOR(N,NX,LV,NUX,S,V,W,EIG,3,W1,W2,W3,Z,D,SD)
00160   31*    WRITE(6,102)
00162   32*    FORMAT(//T10,IMPROVED FREQUENCIES/)
00163   33*    DO 40 I=1,LV
00166   34*    EIG(I)=ABS(EIG(I))
00167   35*    EIG(I)=SQRT(EIG(I))/6.28318
00171   36*    REWIND 19
00172   37*    READ(19)(FRQ(I),I=1,N)
00200   38*    DO 60 I=1,N
00203   39*    IF(1-LV)50,50,51
00206   40*    FRQ(I)=EIG(I)
00207   41*    GO TO 60
00210   42*    FRQ(I)=ABS(FRQ(I))
00211   43*    FRQ(I)=SQRT(FRQ(I))/6.28318
00212   44*    60  CONTINUE
00214   45*    WRITE(6,103)(FRQ(I),I=1,LV)
00222   46*    FORMAT(//T20,BE13.6)
00223   47*    REWIND 35
00224   48*    WRITE(35)(FRQ(I),I=1,N)
00232   49*    100  RETURN
00233   50*    END
END OF COMPIRATION: NO DIAGNOSTICS.

```

FOR IS STEP3,STEP3  
 CYCLE 000 COMPILED BY 1201 ECSTE ON 13 JUL 70 AT 13:22:24.

## SUBROUTINE STEP3 ENTRY POINT 000311

STORAGE USED: CODE(1) 0003401 DATA(0) 046534; BLANK COMMON(2) 000000

## EXTERNAL REFERENCES (BLOCK, NAME)

0003	VREMS
0004	VRBJ\$
0005	VI01\$
0006	VI02\$
0007	VB\$
0010	WDJS
0011	VER3\$

## STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000	046443	104F	0000	046460	105F	0001	000025	1076	0001	000031	1136	0001	000044	1216
0001	000051	124F	0001	000053	1306	0001	000073	1366	0001	000105	1446	0001	000111	1506
0001	000135	1636	0001	000142	1676	0001	000150	1756	0001	000155	2016	0001	000166	2076
0001	000210	2176	0001	000227	2316	0001	000247	2366	0001	000173	35L	0000	R 000000	A
0000	R 046220	DJ4	0000	I 046434	I	0000	I 046474	INJP\$	0000	I 046441	II	0000	I 046442	I2
0000	I 046436	J	0000	I 046435	K	0000	I 046440	LC	0000	I 046437	NV			

```

1*          SUBROUTINE STEP3(N,VV,EIG,W,LV)
2*          PARAMETER NX=140, NVX=30
3*          DIMENSION EIG(NVX),A(NX,NX),W(NX,NVX),DJM(NX)
4*          C
5*          C
6*          C
7*          C
8*          C
9*          C
10*         C
11*         C
12*         C
13*         C
14*         C
15*         C
16*         C
17*         C
18*         C
19*         C
20*         C
21*         C
22*         C
23*         C
24*         C
41          REWIND 15
42          DO 41 I=1,N
43          READ(15)(A(K,I),K=1,N)
44          DO 43 I=1,N
45          DO 42 J=1,LV
46          DJM(J)=0.
47          DO 42 K=1,N
48          DJM(J)=DJM(J)+A(I,K)*W(I,J)
49          A(I,J)=DJM(J)
50          DO 43 J=1,LV
51          NV=NV-LV
52          WRITE(35)(A(I,J),I=1,N)
53          IF(NVV)35,35,30
54          NV=NV-LV
55          IF(NVV)35,35,30
56          REWIND 20
57          DO 21 I=1,LV
58          READ(20)(DJM(I),I=1,N)
59          DO 34 I=1,NV
60

```

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```

00177 25*      READ(20)(DUM(K),K=1,N)
00205 26*      34      WRITE(35)(DUM(K),K=1,N)
00214 27*      35      REWIND 35
00214 28*      C       OUTPUT MODAL INFORMATION
00214 29*      C
00214 30*      C
00215 31*      LC=(N+9)/10
00216 32*      DO 51 I=1,LV
00221 33*      WRITE(6,104)I,EIG(I)
00225 34*      104      FORMAT(//T5,'IMPROVED MODE NO. ,I3,10X,'NORMAL FREQUENCY = ',,
00225 35*      /E11.4, CPS')
00226 36*      I1=1
00227 37*      I2=10
00230 38*      DO 51 J=1,LC
00233 39*      WRITE(6,105)I1,(A(K,I),K=I1,I2),I2
00243 40*      105      FORMAT(2X,I5,3X,10(E11.4),I6)
00244 41*      I1=I1+10
00245 42*      51      I2=I2+10
00250 43*      100     RETURN
00251 44*      END

END OF COMPILATION: NO DIAGNOSTICS.

```

2 FOR IS TRANSF,TRANSF  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:22:45.

SUBROUTINE TRANSF ENTRY POINT 000141

STORAGE USED: CODE(1) 000161; DATA(0) 000043; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000023	1066	0001	000056	1136	0001	000062	1176	0001	000103	1266			
0000	1	000006	1	0000	000011	INJP\$	0000	1	000004	J	0000	I	000002	K
0000	1	000003	K2	0000	I	000000	N2	0000	R	000005	SUM			

```

00101      1*      THIS SUBROUTINE TRANSF(N,A,X,C,M)
00101      2*      THIS SUBROUTINE TRANSFORMS THE EIGENVECTORS OF A TRIDIAGONAL
00101      3*      MATRIX INTO THE EIGENVECTORS OF THE ORIGINAL MATRIX.
00101      4*      A IS THE MATRIX WHICH WAS USED AS INPUT TO TRIDMX, AND
00101      5*      X IS THE MATRIX OF EIGENVECTORS
00103      6*      DIMENSION A(M,M),X(M,M),C(M)
00104      7*      N2=N-2
00105      8*      DO 102 K1=1,N2
00110      9*      K=N-K1
00111     10*      K2=K-1
00112     11*      DO 103 J=1,N
00115     12*      SUM =0
00116     13*      DO 104 I=K,N
00121     14*      SUM =SUM+A(I,K2)*X(I,J)
00123     15*      C(J)=2.*SUM
00125     16*      DO 105 I=K,N
00130     17*      DO 105 J=1,N
00133     18*      X(I,J)=X(I,J)-A(I,J)*C(J)
00136     19*      CONTINUE
00140     20*      RETURN
00141     21*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

FOR IS QR,QR  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:23:08.

SUBROUTINE QR ENTRY POINT 000662

STORAGE JSED: CODE(1) 000717; DATA(0) 000124; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

```
0003 SORT
0004 VERR3$
```

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

```
0001 000061 1066 0001 000102 1116 0001 000130 1246 0001 000156 15L 0001 000437 2045
0001 000535 2316 0001 000570 2446 0001 000211 40L 0001 000215 41L 0001 000232 42L
0001 000632 500L 0001 000317 80L 0001 000333 82L 0001 000336 90L 0000 R 000016 A0
0000 R 000014 A1 0000 R 000020 BETA 0000 R 000013 30 0000 R 000021 COSE 0000 R 000007 EPS
0000 R 000017 FACT 0000 I 000003 I 0000 R 000032 INJP$ 0000 I 000004 J 0000 I 000012 K
0000 R 000002 LAM 0000 I 000010 M 0000 R 000001 MU 0000 I 000011 M1 0000 R 000000 NORM
0000 I 000005 N1 0000 R 000022 SINE 0000 R 000006 SUM 0000 R 000015 T 0000 R 000023 X1
```

1\* THIS SUBROUTINE OR(N,A,B,E,X,SN,C5,C,L)  
00101 2\* SUBROUTINE FINDS THE EIGENVALUES AND EIGENVECTORS OF A  
00101 3\* SYMMETRIC TRIDIAGONAL MATRIX. N IS THE DIMENSION,A(1),...,A(N), THE  
00101 4\* DIAGONAL,B(2),...,B(N) THE OFF-DIAGONAL,E(1),...,E(N) THE EIGENVALUES,  
00101 5\* X(1,K),...,X(N,K) IS THE EIGENVECTOR CORRESPONDING TO E(K), AND SN,  
00101 6\* C5,C ARE ONE DIMENSIONAL WORKING ARRAYS.  
00103 7\* DIMENSION A(L),B(L),E(L),X(L),SN(L),CS(L),C(L),  
00104 8\* REAL NORM ,MULAW  
00104 9\* SET THE X ARRAY EQUAL TO THE NXN IDENTITY  
00105 10\* DO 200 I=1,N  
00110 11\* DO 201 J=1,N  
00113 12\* X(I,J)=0.  
00114 13\* X(J,I)=0.  
00116 14\* X(I,I)=1.  
00120 15\* B(I)=0.0  
00121 16\* NORM = ABS(B(N))+ABS(A(N))  
00122 17\* N1=N-1  
00123 18\* DO 10 I=1,N1  
00126 19\* SUM=ABS(A(I))+ABS(B(I))+ABS(C(I))+ABS(D(I+1))  
00127 20\* IF (SUM .GT. NORM) NORM=SUM  
00131 21\* CONTINUE  
00133 22\* EPS=NORM \* (10.E-8)  
00134 23\* MUL=0.  
00135 24\* IF (MULE.0) GO TO 500  
00136 25\* CHECK FOR POSSIBLE DECOUPLING OF THE MATRIX  
00136 26\* IF (ABS(C(M)).GT. EPS) GO TO 40  
00140 27\* C

```

00142    28*          E(V)=A(V)
00143    29*          V=M-1
00144    30*          GO TO 15
00145    31*          M1=M-1
00146    32*          K=M1
00147    33*          IF(ABS(B(K)).LE.EPS) GO TO 42
00151    34*          K=K-1
00152    35*          GO TO 41
00152    36*          DETERMINE THE SHIFT OF ORIGIN
00153    37*          C        42          B0=3(M)*2
00154    38*          A1=SQRT((A(M1)-A(M))**2+4.*B0)
00155    39*          TEA(M1)*A(M)-B0
00156    40*          A0=A(M1)+A(M)
00157    41*          FACT=1.0
00160    42*          IF(A0 .LT. 0.) FACT=-1.0
00162    43*          LAM=0.5*(A0+FACT*A1)
00163    44*          T=T/LAM
00164    45*          IF (ABS(T-MU)-0.5*A3S(T)) 70,80,80
00167    46*          MU=U
00170    47*          LAM=T
00171    48*          GO TO 90
00172    49*          IF (ABS(LAM-MU)-0.5*ABS(LAM)) 81,82,82
00175    50*          MU=LAM
00176    51*          GO TO 90
00177    52*          MU=T
00200    53*          LAM=0.
00201    54*          A(K)=A(K)-LAM
00202    55*          BETA=B(K+1)
00202    56*          DO THE TRANSFORMATION ON THE LEFT
00203    57*          DO 100 J=K,M1
00206    58*          A0=A(J)
00207    59*          A1=A(J+1)-LAM
00210    60*          30=3(J+1)
00211    61*          TESQRT(A0**2+3*ETA**2)
00212    62*          COSE=A0/T
00213    63*          CS(J)=COSE
00214    64*          SINE=BETA/T
00215    65*          SN(J)=SINE
00216    66*          A(J)=C0SE*A0+SINE*BETA
00217    67*          A(J+1)=-SINE*B0+C0SE*A1
00220    68*          3(J+1)=C0SE*B0+SINE*A1
00221    69*          BETA=3(J+2)
00222    70*          B(J+2)=C0SE*BETA
00223    71*          C(J+1)=SINE*BETA
00224    72*          CONTINUE
00224    73*          DO THE TRANSFORMATION ON THE RIGHT
00226    74*          B(K)=0.
00227    75*          C(K)=0.
00230    76*          DO 110 J=K, M1
00233    77*          SIN=SN(J)
00234    78*          COSE=CS(J)
00235    79*          A0=A(J)
00236    80*          30=B(J+1),
00237    81*          B(J)=3(J)*COSE + C(J)*SINE
00240    82*          A(J)=A0*C0SE+B0*SINE+LAM
00241    83*          3(J+1)=-A0*SINE+30*C0SE
00242    84*          A(J+1)=A(J+1)*C0SE

```

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```
00242 85* C APPLY THE TRANSFORMATIONS TO THE X MATRIX
00243 86* DO 120 I=1,N
00246 87* X0=X(I,J)
00247 88* X1=X(I,J+1)
00250 89* X(I,J)=X0*COS + X1*SINE
00251 90* X(I,J+1)=-X0*SINE + X1*COS
00252 91* 120 CONTINUE
00254 92* 110 CONTINUE
00255 93* A(M)EA(M)+LA(M)
00257 94* GO TO 15
00260 95* RETURN
00261 96* END
```

```
END OF COMPILED: NO DIAGNOSTICS.
```

<sup>2</sup> FOR,IS TRAIP,TRAIP  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:23:28.

SUBROUTINE TRAIP ENTRY POINT 000504

STORAGE JSED: CODE(1) 000554; DATA(0) 000116; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK#, NAME)

0003	VNJJS
0004	VIO2\$
0005	SQRT
0006	VER23\$

STORAGE ASSIGNMENT (BLOCK#, TYPE, RELATIVE LOCATION, NAME)

0001	00045	1116	0001	000065	121G	0001	000123	1266	0001	000161	1416	0001	000175	1476	
0001	000227	1556	0001	000260	164G	0001	000326	2016	0001	000337	2066	0001	000371	2116	
0001	000422	2216	0001	000237	350L	0000	000022	400F	0001	000406	46L	0001	000443	55L	
0001	000454	60L	0000	000002	DA1	0000	000034	DA2	0000	000015	DE0W	0000	D	000006	DSCAL
0000	D	000000 DSUM	0000	1	000010 I	0000	000034	INJPS	0000	I	000014 J	0000	I	000017	JJ
0000	I	000011 K	0000	1	000012 KK	0000	1	000016 L	0000	R	000020 SCAL	0000	R	000013	SUM
0000	R	000021 T													

```

00101 1*          SUBROUTINE TRAIP(N,NW,A,D,B)
00101 2*          -----
00101 3*          C          TRIANGULARIZATION OF REAL SYMMETRIC MATRIX.
00101 4*          C          -----
00103 5*          C          DIMENSION (NM,NM),D(NM),B(NM)
00104 6*          C          DOUBLE PRECISION DSUM,DA1,DA2,DSCAL
00104 7*          C          -----
00104 8*          C          SAVE ORIGINAL DIAGONALS IN ARRAY D.
00104 9*          C          -----
00105 10*         C          WRITE(6,400)
00107 11*         400        FORMAT(*,1NSIDE TRAIP*)
00110 12*         DO 10 I=1,N
00113 13*         10        D(I)=A(I,I)
00113 14*         C          -----
00113 15*         C          FOR N-2 RETURN WITHOUT COMPUTING.
00113 16*         C          -----
00115 17*         C          -----
00115 18*         C          < INDEX CONTROLS THE (N-2) SIMILARITY TRANSFORMATION.
00115 19*         C          -----
00115 20*         C          -----
00120 21*         15        DO 46 I=3,N
00123 22*         C          K=K-1
00123 23*         C          -----
00123 24*         C          SUM CONTAINS THE SUM OF THE SQUARE ELEMENTS
00123 25*         C          OF A COLUMN, EXCEPT THE FIRST -2 ELEMENTS.
00123 26*         C          -----

```



N3 DIAGNOSTICS.

DOLFOR/SI VECTOR,VECTOR  
CYCLE 000 COMPILED BY 1201 00032560 13 JUL 70 AT 13:23:54.

SUBROUTINE VECTOR      ENTRY POINT 000464  
STORAGE USED (BLOCK, NAME, LENGTH)

0001	*CODE	000566
0000	*DATA	000107
0002	*BLANK	000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	TRAIP
0004	QR
0005	TRANSF
0006	YNDUS
0007	N102\$
0010	VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	00043 1066	0001	000141 11L	0001	000075 1116	0001	000101 1156	0001	000145 12L
0001	000420 1206	0001	000301 1606	0001	000324 1666	0001	000366 2046	0001	000404 2156
0001	000411 2206	0001	000413 2246	0000	000024 401F	0001	000374 700L	0001	000356 701L
0000	0 00002 DA	0000	0 000000 35JW	0000	0 00004 DX	0000	0 00006 DY	0000	R 000016 EWIV
0000	R 000021 ETEMP	0000	I 000010 I	0000	I 000017 IWIN	0000	I 000011 J	0000	I 000012 K
0000	I 000014 KL	0000	I 000020 KPI	0000	I 000013 L	0000	I 000015 W1	0000	R 000023 SUM
0000	R 000022 WTEMP								

```

1*   C SUBROUTINE VECTOR(N,NMAX,W,WMAX,A,X,W,EIG,B,W1,W2,W3,Z,D,SD)
00101 2*   C THIS SUBROUTINE USES A GENERALIZED RAYLEIGH METHOD TO IMPROVE THE ACCURACY
00101 3*   C OF N SELECTED EIGENVALUES AND EIGENVECTORS OF AN N BY N
00101 4*   C SYMMETRIC MATRIX A. THE LOWER TRIANGULAR PART OF A IS STORED
00101 5*   C COLUMN BY COLUMN IN A ONE DIMENSIONAL ARRAY, CALLED A. THE N
00101 6*   C ORTHONORMAL EIGENVECTORS ARE STORED COLUMN WISE IN THE N BY N
00101 7*   C ARRAY X. THE IMPROVED EIGENVALUES WILL BE STORED IN EIG, AND THE
00101 8*   C CORRESPONDING VECTORS IN W. THE FOLLOWING ARRAYS ARE ALSO NEEDED.
00101 9*   C BY N ARRAYS B, Z, AND S W BY 1 ARRAYS W1, W2, W3, D, SD.
00101 10*  C THE SUBROUTINE CALLS TRIMX, QR, AND TRANSF.
00103 11*  C DIMENSION N,NMAX,W,WMAX,EIG(WMAX),W1(WMAX),W2(WMAX),W3(WMAX),
00103 12*  C Z(WMAX,WMAX),WMAX,W(NMAX),SD(WMAX),S(NMAX),
00103 13*  C X(NMAX,WMAX),A(NMAX)
00104 14*  C DOUBLE PRECISION DSUM, DA,CX,CY
00104 15*  C FIND THE B MATRIX
00105 16*  C DO 40 I=1,M
00110 17*  C DO 40 J=1,M
00113 18*  C DSUM=0.

```

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00114   19*      20 41 K=1,N
00117   20*      22 41 L=1,N
00122   21*      IF (L-K) 10 10,11
00125   22*      K=L+(L-1)*N-L*(L-1)/2
00126   23*      GO TO 12
00127   24*      K=L+(K-1)*N-K*(K-1)/2
00130   25*      CONTINUE
00131   26*      DAE(A(KL))
00132   27*      DX=X(<0.1)
00133   28*      CY=X(L,J)
00134   29*      DSUM=DSUM+DA*D(X*CY
00137   30*      B(I,J)=DSUM
00140   31*      B(J,I)=DSUM
00141   32*      CONTINUE
00144   33*      CALL TRAP(M,MAX,B,D,SD)
00145   34*      WRITE(6,401)
00147   35*      FORMAT(1)
00150   36*      CALL QR(M,J,SD,EIG,Z,W1,W2,W3,MAX)
00151   37*      WRITE(6,401)
00153   38*      CALL TRANSF(M,3,Z,W1,MAX)
00154   39*      WRITE(6,401)
00154   40*      C ARRANGE THE IMPROVED EIGENVALUES IN ORDER OF INCREASING MAGNITUDE
00156   41*      M=MAX-1
00157   42*      GO TO 700 K=1,M1
00162   43*      IMIN=ABS(EIG(K))
00163   44*      IMIN=K
00164   45*      KP1=K+1
00165   46*      GO TO 701 J=KP1,M
00170   47*      IF (EWIN .LE. ABS(EIG(J))) GO TO 701
00172   48*      IMIN=ABS(EIG(J))
00173   49*      IMIN=J
00174   50*      CONTINUE
00174   51*      C THE MINIMUM OF ABS(EIG(K))...ABS(EIG(M)) IS ABS(EIG(IMIN))
00176   52*      IF (IMIN .EQ. K) GO TO 700
00200   53*      ETMP=EIG(IMIN)
00201   54*      EIG(IMIN)=EIG(K)
00202   55*      EIG(K)=ETMP
00203   56*      DO 702 J=1,M
00206   57*      WTEMP=Z(J,IMIN)
00207   58*      Z(J,IMIN)=Z(J,K)
00210   59*      Z(J,K)=WTEMP
00212   60*      CONTINUE
00214   61*      DO 50 K=1,M
00217   62*      DO 51 I=1,N
00222   63*      SUM=0.
00223   64*      DO 52 J=1,M
00226   65*      SUM=SUM + Z(J,K)*X(I,J)
00230   66*      W(I,K)=SUM
00232   67*      CONTINUE
00234   68*      RETURN
00235   69*      END

```

END OF COMPILE: NO DIAGNOSTICS.

3 FOR'IS SHAPES,SHAPES  
CYCLE 000 COMPILED BY 1201 3CSTE ON 13 JUL 70 AT 13:24:10.

SUBROUTINE SHAPES ENTRY POINT 000024

STORAGE JSEG: CODE(1) 000044; DATA(0) 000005; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 SHAP1  
0004 SHAP2  
0005 VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000 000000 INPS

00101 1\* SUBROUTINE SHAPES(NTS,ND,NMQ,NC,NV)  
00103 2\* DIMENSION ND(9),NMQ(9)  
00104 3\* CALL SHAP1(NTS,ND,NMQ,NC,NV)  
00105 4\* CALL SHAP2(NTS,ND,NV,NC)  
00106 5\* RETURN  
00107 6\* END

END OF COMPILATION: NO DIAGNOSTICS.

<sup>2</sup> FOR IS SHAP1,SHAP1  
CYCLE 000 COMPILED BY 1201 3C57E ON 13 JUL 70 AT 13:24:34.

SUBROUTINE SHAP1 ENTRY POINT 000323

STORAGE USED: CODE(1) 000350; DATA(0) 060040; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	VREF\$
0004	VRBJ\$
0005	VI01\$
0006	VI02\$
0007	VMBUS
0010	NERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000041	110G	0001	000047	115G	0001	000053	121G	0001	000072	130G	0001	000121	136G
0001	000127	143G	0001	000141	151G	0001	000145	155G	0001	000160	163G	0001	000163	166G
0001	000165	172G	0001	000204	201G	0001	000217	207G	0001	000222	212G	0001	000224	216G
0001	000243	225G	0001	000255	233G	0001	000261	237G	0000	R 021450	B	0000	R 057756	0D
0000	R 057520	DJM	0000	R 000000	FI	0000	R 057754	GK	0000	I 057747	I	0000	057770	INJP\$
0000	I 057750	ISEG	0000	I 057751	IUNIT	0000	I 057755	J	0000	I 057746	K	0000	I 057753	NDI
0000	I 057752	NMQI	0000	R 037200	SI									

```

00101      1*
00103      2*
00104      3*      C
00104      4*      C
00105      5*      C
00106      6*      C
00114      7*      C
00117      8*      1
00126      9*      READ(35)(SI(K,I),K=1,NC)
00127      10*     REWIND 35
00127      11*     DO 1 I=1, NV
00132      12*     READ(35)(SI(K,I),K=1,NC)
00133      13*     DO 11 ISEG=1, NTS
00134      14*     DO 11 ISEG=1, NTS
00135      15*     C
00140      16*     2
00150      17*     3
00153      18*     C
00153      19*     C
00153      20*     C
00153      21*     C
00162      22*     DO 6 I=1, NMQI
00165      23*     DO 5 J=1, NV
00170      24*     DO=0.

```

COMPUTE 3\*SI AND STORE RESULTS IN B

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```

00171 25*      DO 4 K=1,NC
00174 26*      4      DD=DD+3(I,K)*SI(K,J)
00176 27*      5      DJM(J)=DD
00200 28*      6      DO 6 J=1,NV
00203 29*      6      B(I,J)=DJM(J)
00203 30*      C      COMPUTE FI*(3*SI) AND STORE IN FI
00203 31*      C
00203 32*      C      DO 9 I=1,NDI
00206 33*      C      DO 8 J=1,NV
00211 34*      C
00214 35*      C      DD=0.
00215 36*      C      DO 7 K=1,NMQL
00220 37*      7      DD=DD+FI(I,K)*B(K,J)
00222 38*      8      DJM(J)=DD
00224 39*      8      DO 9 J=1,NV
00227 40*      9      FI(I,J)=DJM(J)
00227 41*      C      WRITE FI IN TAPE NO. 36 ROW 3Y ROW
00227 42*      C
00227 43*      C      DO 10 I=1,NDI
00232 44*      C      WRITE(36)FI(I,J),J=1,NV
00235 45*      10
00235 46*      C
00244 47*      11  CONTINUE
00244 48*      C
00246 49*      100 RETURN
00247 50*      END
END OF COMPIRATION: NO DIAGNOSTICS.

```

3 FOR,IS SHAP2,SHAP2  
 CYCLE 000 COMPILED BY 1201 3CS7E ON 13 JUL 70 AT 13:24:57.

SUBROUTINE SHAP2 ENTRY POINT 000315

STORAGE JSEQ: CODE(1) 000336; DATA(0) 062421; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003	VWJS
0004	VI02\$
0005	VRJS
0006	VI01\$
0007	VREWS
0010	VERR3\$

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000273	100L	0000	062315	101F	0000	062335	102F	0000	062351	103F	0000	062355	104F
0001	000056	11L	0000	062324	110F	0001	000023	111G	0001	000035	117G	0001	000060	12L
0001	000070	140G	0001	000074	144G	0001	000104	151G	0001	000114	157G	0001	000132	170G
0001	000047	20L	0001	000155	202G	0001	000160	205G	0001	000205	220G	0001	000222	230G
0001	000236	2356	0000	R 062050	DJW	0000	R 000000	FI	0000	R 061634	FRA	0000	I 062276	I
0000	I 062310	IM	0000	062366	INJP\$	0000	I 052303	IR	0000	I 062304	ISEG	0000	I 062313	I1
0000	I 062314	12	0000	I 062311	J1	0000	I 062306	K	0000	I 062302	K2	0000	I 062301	K2
0000	I 062307	L	0000	I 062312	LC	0000	I 062305	NDI	0000	I 062277	NJP			

 1\* SUBROUTINE SHAP2(VTS,ND,NN,NC)  
 DIMENSION FI(850,30), VD(9),FRQ(140), JUM(150)

PRINT SYNTHESIS RESULTS -- FREQS AND MODE SHAPES

00103	2*	C	WRITE(6,101)	FORMAT('1',//45X,'MODAL SYNTHESIS RESULTS',//)			
00103	3*	C	0104	READ(35)(FR3(I),I=1,NC)			
00103	4*	C	0106	WRITE(6,110)(FRQ(I),I=1,NC)			
00103	5*	C	0107	FORMAT('//T5,'LIST OF FREQUENCIES (CPS)//(T10,10E12.5))			
0104	6*		0115	0123	10*	110	GET MODE SHAPES FROM TAPE NO. 36 AND STORE IN FI
0106	7*		0123	11*	C	REWIND 36	NOPEN
0107	8*		0123	12*	C	ND=0	
0115	9*		0123	13*	C	IF((NP-30)>10,10,11	
0123	10*		0123	14*	C	K2=NN	
0124	15*		0125	16*		GO TO 12	
0125	16*		0126	17*		K2=30	
0126	17*		0127	18*		K1=1+NDK	
0127	18*		0132	19*		IR=0	
0132	19*		0133	20*			
0133	20*		0134	21*			
0134	21*		0135	22*			
0135	22*		0136	23*			

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00137 24*      DO 1 ISEG=1,NTS
00142 25*      NDI=NDC(1ISEG)
00143 26*      DO 1 I=1,NDI
00146 27*      IR=IR+1
00147 28*      READ(36)(JUM(K),K=1,NV)
00155 29*      L=0
00156 30*      DO 1 K=K1,K2
00161 31*      L=L+1
00162 32*      FI(IR,L)=JUM(K)
00166 33*      L=0
00167 34*      DO 5 IM=K1,K2
00172 35*      L=L+1
00172 36*      C
00173 37*      WRITE(6,102)IM,FRQ(IM)
00177 38*      102 FORMAT(//,T20,'MODE NO. ',I3,10X,'NORMAL FREQUENCY =',E10.4,' CPS')
00177 39*      /
00200 40*      J1=0
00201 41*      DO 4 ISEG=1,NTS
00204 42*      DO 2 I=1,150
00207 43*      2 DUM(I)=0.
00211 44*      WRITE(6,103)ISEG
00214 45*      103 FORMAT(2X,'SEGMENT ',I2)
00215 46*      NDI=NDC(1ISEG)
00216 47*      LC=(NDI+9)/10
00217 48*      DO 3 I=1,NDI
00222 49*      J1=J1+1
00223 50*      3 DUM(I)=FI(J1,L)
00225 51*      I1=1
00226 52*      I2=10
00227 53*      DO 4 I=1,LC
00232 54*      WRITE(6,104)I1,(JUM(K),K=I1,I2),I2
00242 55*      I1=I1+10
00243 56*      4 I2=I2+10
00246 57*      104 FORMAT(2X,I5,3X,10(E11.4),I6)
00246 58*      C
00247 59*      5 CONTINUE
00247 60*      C
00251 61*      REWIND 36
00252 62*      NVP=NVP-30
00253 63*      IF(NVP)100,100,13
00256 64*      13 NDK=30
00257 65*      GO TO 20
00260 66*      100 RETURN
00261 67*      END
END OF COMPIRATION:    NO DIAGNOSTICS.

```

**BELLCOMM, INC.**

SUBJECT: Multi-Segment Modal Synthesis  
for Large Dynamic Systems  
Case 620

FROM: S. N. Hou

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